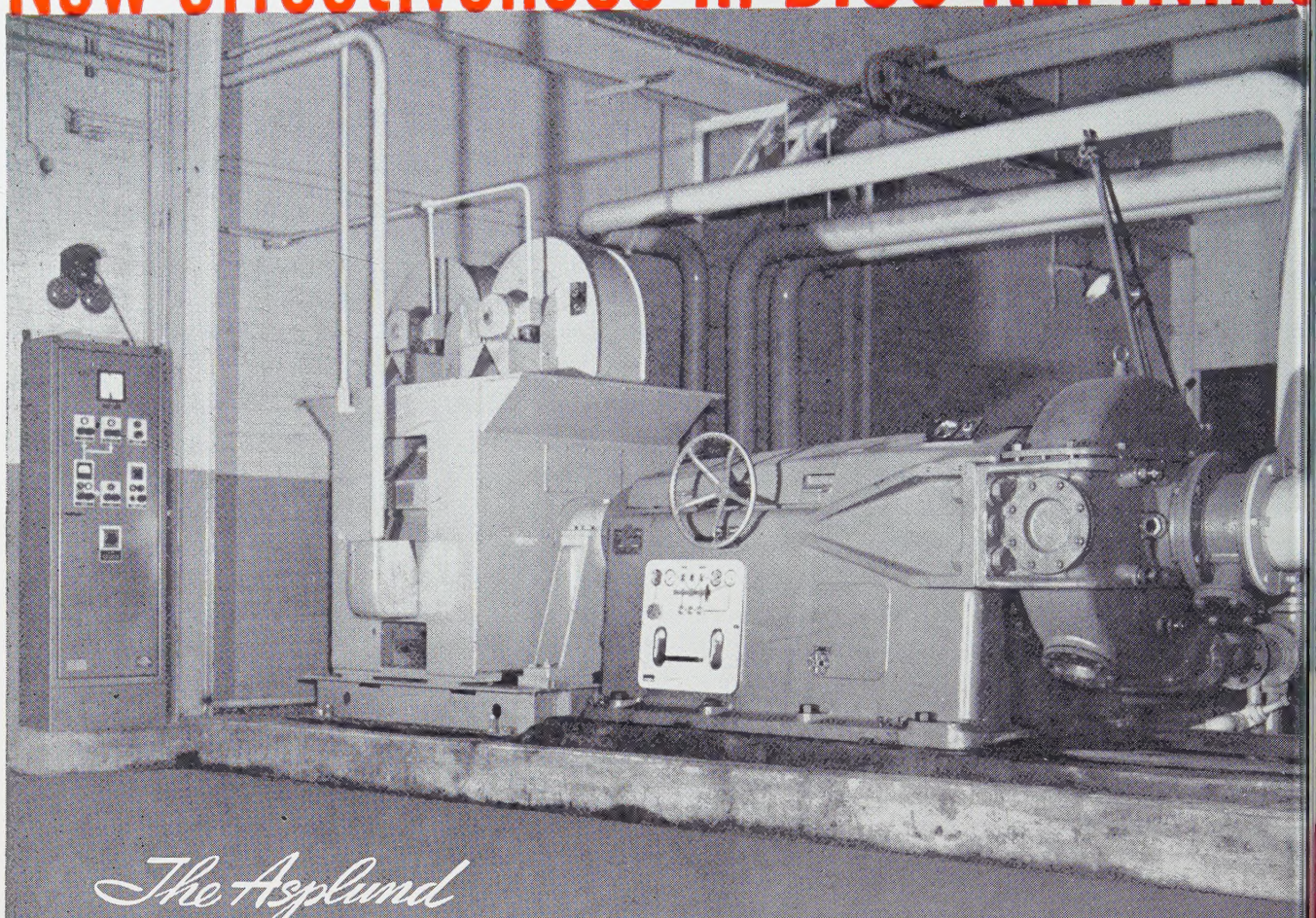
Tappi

HE JOURNAL OF THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

SEPTEMBER 1961

VOLUME 44 • NUMBER 9

New effectiveness in DISC REFINING



The Asplund

RAFFINATOR

In a mid-western mill on semi-chemical furnish

NORTH AMERICAN MILLS are discovering advantages present only in the Raffinator Disc Refiner for getting highest strength development in all kinds of pulp at consistencies up to 20%.

For example, the Raffinator's exclusive hydraulic control system provides absolute uniformity of clearance between the plates at all points. The rotating disc is positioned with positive, constant control — can be operated at a fixed clearance or on a floating principle to accommodate varying stock pressures. Through a clearance indicator, screen plate settings are conveniently seen magnified 80 times.

Split shell facilitates setting the rotor and static discs in perfect alignment at tolerance of .0001″ or less. Oversize shaft prevents deflection.

Rugged, dependable and efficient, the Raffinator comes complete with electrical system, control panel and automatic safety devices. All parts exposed to stock are made of stainless steel.

Currently proving its effectiveness in over 600 European installations, this high precision disc refiner, an Asplund invention, is engineered and manufactured in Sweden by Aktiebolaget Defibrator. It is now made available to North American mills by Bolton-Emerson.

Get all the facts about the Raffinator Disc Refiner from The Emerson Manufacturing Co., Division of John W. Bolton & Sons, Lawrence, Massachusetts.

BOLTON EMERSON
TRADE MARK

Looking for "Bugs"

in Huyck's Customer Service Department

These men are not entomologists. They are Huyck Customer Service Engineers studying a used felt. Looking for ways to make better felts is their job. They may check portions of this felt in our laboratory for chemical damage, type of plugging material or excessive wear, thus pinpointing causes for removal.

Such unique and complete services complement Huyck's advanced design engineering — further assurance that Huyck performance means High Performance on your machines.

HUYCK FELTS

Huyck Felt Co., Rensselaer, N. Y.; Aliceville, Ala.

Division of Huyck Corporation

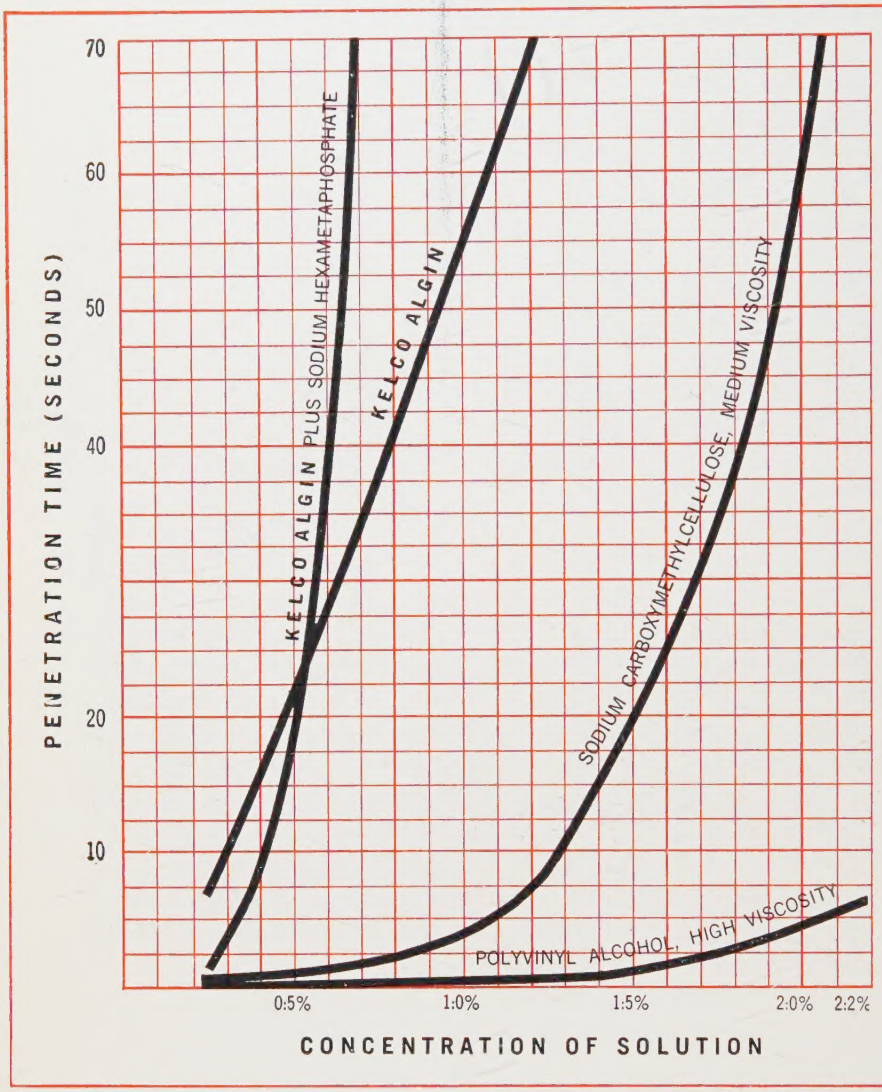
In Canada: Kenwood Mills Limited, Arnprior, Ontario

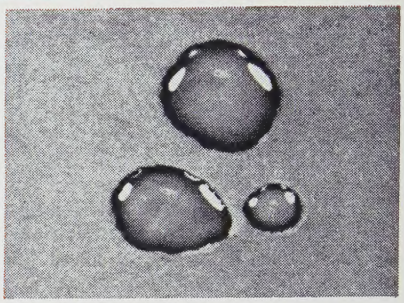
FIRST IN FELTS SINCE 1870

REC'D OCT - 2 1961

Remarkable! The way Kelco Algins give greater

PENETRATION





This photograph shows a 1% solution of Kelco Algin twenty minutes after being puddled on blotter. Note how algin controls penetration and retains solution on surface of blotter. This test illustrates the outstanding ability of algin to control penetration. With it you can get the exact degree of hold-out desired for sizings, coatings, adhesives, inks, etc.

Here is photograph of water, without algin, on same piece of blotter taken seconds after water was placed on blotter. Note how water passed immediately into blotter compared to controlled penetration of algin solution.

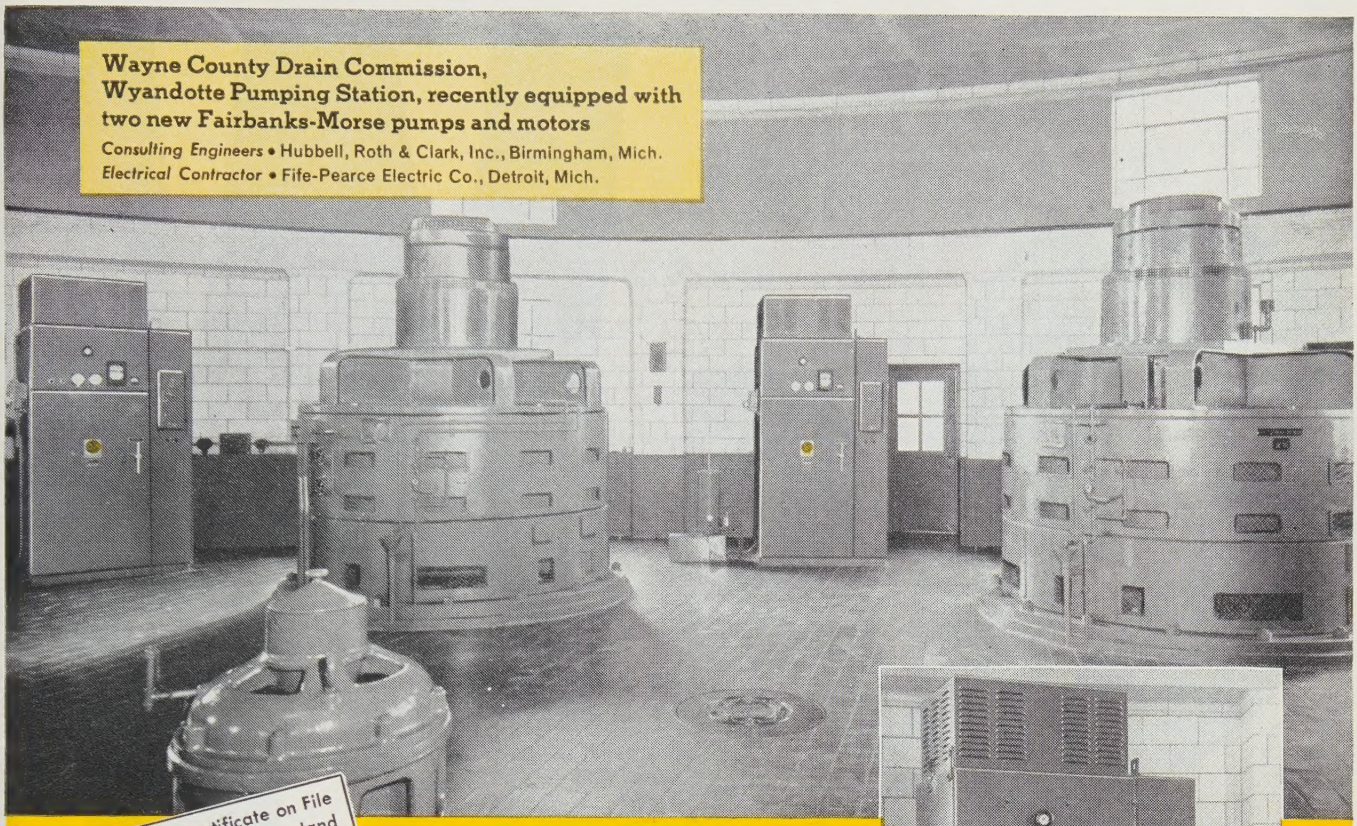
CONTROL

This graph and blotter test illustrate and prove that KELCO ALGIN products are among the most efficient materials available for controlling penetration. By using proper proportions of a product such as KELGIN, KELGIN LV, KELGIN XL or KELSIZE, manufacturers of paper products can regulate the amount of penetration of size formulations, clay and wax coatings, printing inks, adhesives, etc. Of course, having your formulation where you want it, without excessive and unnecessary penetration, saves you money.

MAKE YOUR OWN TEST: Samples, information and technical service, yours on request without obligation.

KELGIN® KELGIN LV KELGIN XL KELSIZE S® products of **KELCO COMPANY.**

75 Terminal Avenue, Clark, N. J. • 20 N. Wacker Drive, Chicago 6, Ill. • 530 W. Sixth Street, Los Angeles 14, Calif. Cable Address: KELCOALGIN—CLARKNEWJERSEY



Wayne County Drain Commission,
Wyandotte Pumping Station, recently equipped with
two new Fairbanks-Morse pumps and motors

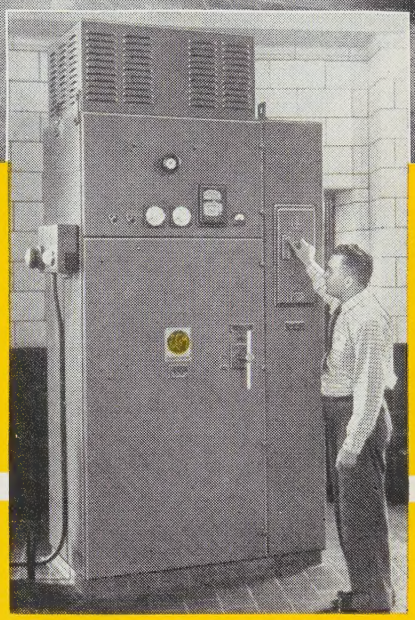
Consulting Engineers • Hubbell, Roth & Clark, Inc., Birmingham, Mich.
Electrical Contractor • Fife-Pearce Electric Co., Detroit, Mich.

Certificate on File in Cleveland

Certified Fault Protection WITHOUT FUSES!

EC&M Fuseless Starters

ELIMINATE FUSE PROBLEMS & COSTS



Now you can get full fault protection without the problems associated with fuses. EC&M's fuseless starters have certified interrupting capacities of 100,000 KVA at 2400 volts, 150,000 KVA at 4800 volts — an important consideration when starters were selected for the 1250-hp, 4800-volt starters at Wyandotte Pumping Station. This inherent fault protection is an EC&M "exclusive" — and is available with no first-cost premium.

EC&M starters are safe and easy to maintain. A three-way door interlock gives positive personnel protection, and an interlock is provided between the contactor and disconnect switch. Disconnect blades are visible in the open position when the door is open. No roll-out or draw-out needed for maintenance. All six contacts can be replaced without special tools in 10 minutes or so.

These cost-saving features make EC&M starters the logical choice for 2200-4800 volt motor drives.

TYPICAL SAVINGS WITH EC&M STARTERS

	Fused Starter	EC&M Fuseless Starter
Cost of 1250-hp 4800-volt Starter	$xxx.xx	Same as Fused Starter
Spare Fuse Costs: Set of 3 Spare Fuses for 1250 hp	$470.00	0

***SAVE** per starter, up to $500*
(more on larger motors)
...with EC&M Fuseless Starters

Write FOR DETAILS • Ask for Bulletin 8130
Square D Company, EC&M Division, 4500 Lee Road, Cleveland 28, Ohio

SQUARE D COMPANY
EC&M DIVISION • CLEVELAND 28, OHIO
wherever electricity is distributed and controlled

6520

If you're looking for more brightness in filler clays, many paper makers find that SWW is their answer. SWW's GE Brightness is 82-83.5 percent, but it is equivalent in all other physical properties to air-floated filler clays.

SWW is available in lump or pulverized form. It can be shipped bagged via boxcar or truck; bulk in hopper or box cars.

SWW is one of the complete range of filler and coating clays, air-floated and water washed, supplied by Huber to the paper and container industries.

Write for working samples.

SWW SPECIAL WATER WASHED

HUBER **J. M. HUBER CORPORATION** · 630 Third Avenue, New York 17, New York

Mines and Plants: Huber, Ga., Graniteville and Langley, S.C.

published monthly by the

Technical Association
of the
Pulp and Paper Industry

Editorial and Advertising Offices:

360 Lexington Avenue
New York 17, New York

EDITORIAL DIRECTOR
R. G. MACDONALD

EDITOR
R. T. BINGHAM

TECHNICAL EDITOR
MICHAEL KOURIS

Tappi is published monthly by the Technical Association of the Pulp and Paper Industry at 20th and Northampton Streets, Easton, Pa. Editorial and advertising offices, 360 Lexington Avenue, New York 17, N. Y. Articles for publication and communications regarding the editorial content of **Tappi** should be addressed to the Editor at the editorial office. Statements and opinions expressed in articles and editorials appearing in **Tappi** are those of the contributors, and the Technical Association of the Pulp and Paper Industry assumes no responsibility for them.

Subscription: U. S. and possessions $10.00; Canadian $11.00; Pan American Union $12.00; Other Foreign $13.00. Single copies to members of TAPPI $1.00; Nonmembers $1.50.

Second-class mail privileges authorized at Easton, Pa. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized January 27, 1949.

© Copyright 1961, by the Technical Association of the Pulp and Paper Industry. An index of the technical articles appearing in the magazine appears in the Industrial Arts Index and the Engineering Index.

The Technical Articles are in accord with the recommendations of the Division of Pulp, Paper, and Board of the International Union of Pure and Applied Chemistry.

All the publications of the Technical Association of the Pulp and Paper Industry may be obtained from the offices at 360 Lexington Avenue, New York 17, N. Y.

SEPTEMBER 1961

Vol. 44, Number 9

Tappi

TECHNICAL SECTION

609 **The Manufacture of Welded Stainless Steel Tubing for Maximum Corrosion Resistance in Kraft Evaporators**
S. E. Doughty and W. J. Comerford

614 **Report of TAPPI Flat Crush Study**
Committee Assignment No. 689

620 **Brightness of High Yield Pulps. III. Further Studies in Bleaching With Sodium Borohydride**
Philip Luner and Robert Supka

625 **Papermaking Characteristics of Cedar Fiber**
C. E. Murray and B. B. Thomas

633 **Measuring and Specifying Bulge and Crush Resistance in Cartons and Carton Board**
Paul Cope

636 **Kinetics of the Thermal Degradation of Cellulose Nitrate as Measured by an Improved Taliani Procedure**
Merrill A. Millett, Raymond M. Seborg, Lawrence L. Zoch, and Frank J. Masuelli

647 **Measurement of Kamyr Continuous Kraft Digester Cooking Cycle Using Radioactive Tracers**
Richard P. Hamilton

656 **Alkaline Hydrolysis of Representative Hardwoods. V. Additions and Corrections to Previous Studies**
Irwin A. Pearl, Donald L. Beyer, and Donald Whitney

662 **Hydroxyethylated Cotton Linters with Low Levels of Substitution**
Robert H. Gillespie, Marjorie Mueller, Harold Swenson, and Kyle Ward, Jr.

669 **Conditions Influencing the Viscosity Reduction of Cellulose in Its Esterification with Lower Aliphatic Anhydrides**
Carl J. Malm, R. E. Glegg, Leo J. Tanghe and Janet Thompson

678 **Sequential Startup Procedure for Pulp Drying Machine**
J. Glenn Olree

684 **Studies on Moisture Transmission Rates Through Quarter-Inch Plywood at Different Moisture Content Levels**
R. D. Ziegler

CONTENTS CONTINUED ON NEXT PAGE

Tappi

SEPTEMBER CONTENTS — *continued*

PRESIDENT

H. M. ANNIS
Oxford Paper Co.
230 Park Ave., New York 17, N. Y.

VICE-PRESIDENT

J. C. WOLLWAGE
Kimberly-Clark Corp.
Neenah, Wis.

EXECUTIVE SECRETARY

P. E. NETHERCUT
Technical Association of the Pulp and Paper Industry
360 Lexington Ave.
New York 17, N. Y.

TREASURER

R. G. MACDONALD

PUBLICATIONS COMMITTEE

J. C. WOLLWAGE
W. C. BLOOMQUIST
G. C. KIMBLE
W. P. LAWRENCE
H. A. SPENCER

EDITORIAL BOARD

C. B. CHRISTIANSEN
J. V. CUNDELAN
R. A. DANDO
C. P. DONOFRIO
R. E. DURST
JOHN FRANKEVICZ
J. W. GILBERT
R. S. VON HAZMBURG
M. S. KANTROWITZ
E. G. LOCKE
G. G. MALTENFORT
E. F. MANOGUE
R. C. MASTERMAN
M. N. MAY
R. H. MOSHER
W. W. ROEHR
J. R. SANBORN
J. E. SAPP
F. R. SHELDON
H. A. SPENCER
H. W. STEVENS
J. F. THERIAULT
J. WEINER

ASSOCIATION SECTION

Better Utilization of Technical Manpower

12A The Need for Consideration of Technical Personnel
William G. Torpey

14A The Developing Role of the Technician
H. Russell Beatty

18A The First Five-Year Plan of the Engineers Joint Council for Professional Development
John Gammell

28A Parallel Incentive Systems for Supervisory and Nonsupervisory Professional Personnel
C. B. Munton

93A **Association News and Events**

96A Sixteenth Plastics-Paper Conference Tentative Program

98A Sixteenth Engineering Conference Program Additions

TAPPI Notes

100A TAPPI'S Twenty-Five Year Members
P. E. Nethercut

TAPPI Profile

104A William H. Aiken

106A **Personal Mention**

Industry Notes

109A Paper Manufacturers and Converters

116A Educational Institutions

119A Industry Suppliers

124A General

Divisions and Committees

126A Authorized Committee Assignments

126A Coating and Graphic Arts Division
Adhesive Studies Committee

Engineering Division

128A Process Instrumentation Committee

128A Project 775—Principles of "On the Machine" Moisture Measuring Systems

129A **Employment Service**

Technical Information Sheets

131A Acidproof Brick Chemical and Physical Properties—Technical Information Sheet No. 3

Technical Information Sheets, (*continued*)

132A Physical and Mechanical Properties of Mortars for Chemical Resistant Masonry Construction—Technical Information Sheet No. 4

133A Chemical Resistance of Typical Mortars for Corrosion Resistant Masonay Construction—Technical Information Sheet No. 5

135A Power Requirements of Feltless Pulp Machines—Technical Information Sheet No. 6

136A **TAPPI Fibrary. Addendum V**

Local Section Activities

137A Officers and Executive Committees

141A Review of 1960–61 Section Meetings

146A Chicago

The Development of Plastics as a Packaging Medium—Keynote Comments
Mike Hecht

147A Plastic Films
Ralph Krueger

149A Polyethylene Extrusion Coating—How Is It Doing? Where Is It Going?
A. E. Irvine

151A Plastic Coatings and Packaging
Warren C. Ashley

154A Ohio
NCR Capsular Development
R. W. Saudberg

156A New England (Bay District)
A New Anionic Polyacrylamide Flocculant
Norman T. Woodberry

161A **Review of the Literature on Pulp and Paper Mill Wastes—1960**

Papers of Current Interest

166A Gravure Inks in Relationship to Printing Surfaces
W. S. Webster

168A Paper Mill Boiler Feedwater Practices
M. H. Borland

171A A Preliminary Report on a New Fourdrinier Wire Weave
James E. Watson

172A Fire Testing Procedures
R. H. Neisel

176A Box Shop Quality Control
Robert J. Harlow

178A Microcomponents, Their Effect on Mass Appearance. Practical Application of Microscopy in the Graphic Arts
Ernest Schmatolla

181A Water Requirements and Treatment for High Pressure Boilers
Hugh E. Carr

185A Heat Transfer Printing
R. G. Shepherd, Jr.

188A **United States Patents on Papermaking—Fourth Quarter, 1961**
Compiled by the Institute of Paper Chemistry

COMING EVENTS:

National Conferences

Sixth Deinking Conference
Hotel Harris, Kalamazoo, Mich.
Oct. 4–6, 1961

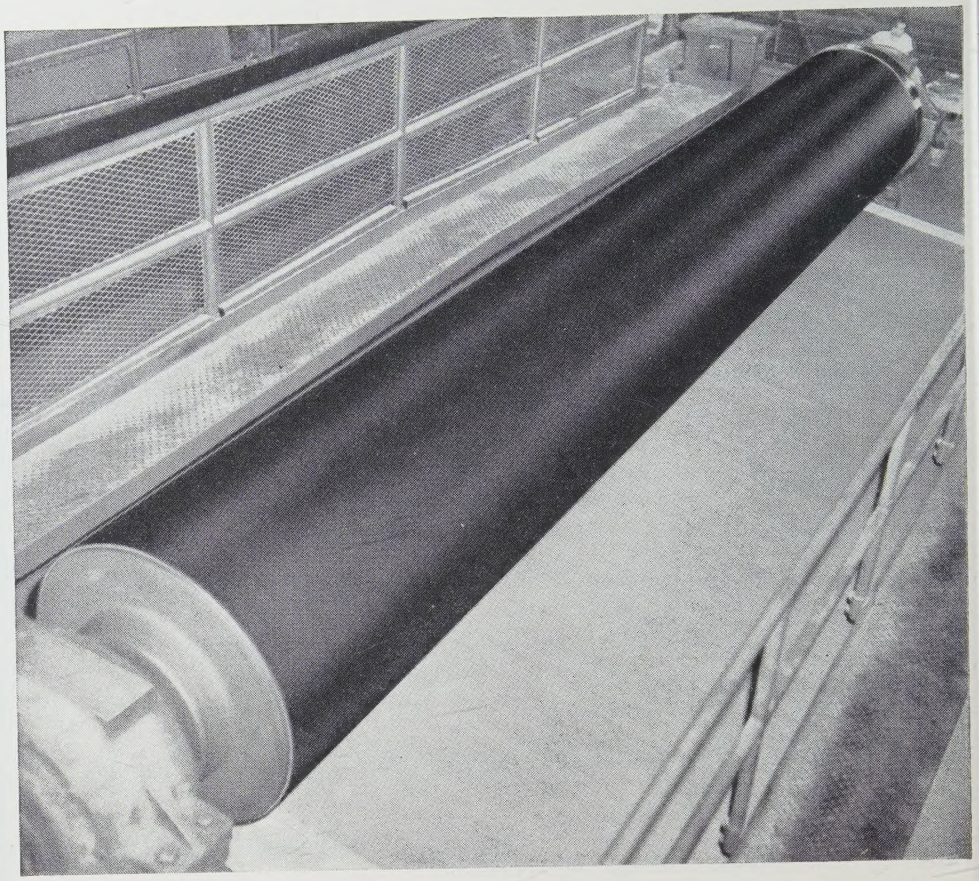
Sixteenth Plastics-Paper Conference
French Lick Sheraton Hotel,
French Lick, Ind.
Oct. 9–11, 1961

Sixteenth Engineering Conference
Shoreham Hotel, Washington, D. C.
Oct. 15–19, 1961

Fifteenth Alkaline Pulping Conference
Rice Hotel, Houston, Tex.
Nov. 1–3, 1961

Please refer to Local Section Activities for the locations and dates of Section Meetings

- **No Doctor**
- **No Wipe**
- **No Shower**
- **No Spray**



World's Largest "Self-Skinner" Roll

Only MANHATTAN "SELF-SKINNER" ROLLS

Give You

- **Quality Finish • More Water Removal at Less Cost**
- **Increased Felt Life • Fewer Breaks—Less Down-Time**
- **More Production at Top Speeds**

Without Doctors

Only the special paper-repellent composition and cushion-like nip of a Manhattan "Self-Skinner" Roll can assure these advantages.

All Manhattan Rubber Covered Rolls are engineered for *specific critical functions*—from web to dryer.

Get "More Use per Dollar" down the line . . . have a Manhattan roll specialist show you the advantages of using work rolls rubber covered by Manhattan, serving the paper industry since 1893.

- ***Self-Skinner, Ray-Roc, Rub-Roc and Sham-Roc Press Rolls*** • ***Suction Press and Coating Rolls***
- ***Sealed-End Couch Rolls*** • ***Marblex Table Rolls***

Facilities near you . . .

ROLL COVERING PLANTS AT PASSAIC, N. J. • NEENAH, WISC. • N. CHARLESTON, S. C.

RAYBESTOS-MANHATTAN, INC.

MANHATTAN RUBBER DIVISION • PASSAIC, N. J.

ENGINEERED RUBBER PRODUCTS

RM109

CONTROLLED
BRIGHTNESS WITH

BLANCOPHOR®

BRIGHTENERS

BLANCOPHOR optical brighteners bring you in on target as to results. The reliability of these products and the wide range in which they are offered allow you to meet just about every specification of reflectance and hue. Match Blancophor products to your process with the help of this chart. Then check the products you are interested in right on the coupon to secure literature and samples.

BLANCOPHOR PRODUCT	SOLUBILITY IN WATER	DAYLIGHT HUE greenest hue = 1 pinkest hue = 4	USE pH	EXHAUST RATE	APPLICATION METHOD
ES-31 (liquid) ES-73 (powder)	15%	3	4-4.5	Moderate	Beater or Size Press
HL-32 (liquid) HL-72 (powder)	10%	2	4-6.5	Moderate to Fast	Beater
HS-31 (liquid) HS-71 (powder)	15%	4	6-7	Moderate	Beater or Size Press
MS-31 (liquid) MS-72 (powder)	10%	1	4-5	Fast	Beater

FROM RESEARCH TO REALITY

GENERAL DYESTUFF COMPANY

A DIVISION OF

GENERAL ANILINE & FILM CORPORATION

435 HUDSON STREET • NEW YORK 14, NEW YORK

SALES OFFICES: Charlotte • Chattanooga • Chicago • Los Angeles • New York
Philadelphia • Portland, Ore. • Providence • San Francisco
IN CANADA: Chemical Developments of Canada Ltd., Montreal

GENERAL DYESTUFF COMPANY
435 Hudson Street, New York 14, N. Y.

Gentlemen:

Please send me samples of the Blancophor products checked and pertinent literature.

☐ ES-31 ☐ ES-73 ☐ HL-32 ☐ HL-72 ☐ HS-31 ☐ HS-71 ☐ MS-31 ☐ MS-72

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE___ STATE_____

Blancophor brighteners manufactured by General Aniline & Film Corporation are sold outside the United States, by distributors all over the world, under the trademark "Tintofen.®"

FLUIDICS AT WORK

In the foreground is the newest of four Permutit Precipitators at Eastman Kodak's Lake Water Works on Lake Ontario near Rochester, N.Y.

HOW KODAK TURNS 24 MGD OF ITS LAKE WATER REQUIREMENTS INTO PURE WATER FOR CRITICAL USES

■ Row a mile and a half due north from this water plant. Dive 55 feet. You're at the intake end of Eastman Kodak Company's water system.

Travel six miles inland. You're at the Kodak Park Works, where the same water goes into critical manufacture of such quality products as photographic film, paper, and chemicals.

How this raw water, gulped from the lake in such great volume, quickly and economically turns into pure process water is the story behind our picture above.

Heart of the water system: precipitation

Kodak treats this water in three steps: (1) chemicals, (2) precipitation, (3) rapid sand filtration. The heart of the system is the removal of turbidity and color by precipitation, accomplished with four Permutit Precipitators.

One-hour detention time: savings in space, chemicals

Detention as short as one hour is possible with the Permutit Precipitator — as against two to four hours required in old-method lime treatment and coagulation plants. This higher throughput can save as much as 50% in space to handle a given volume of water.

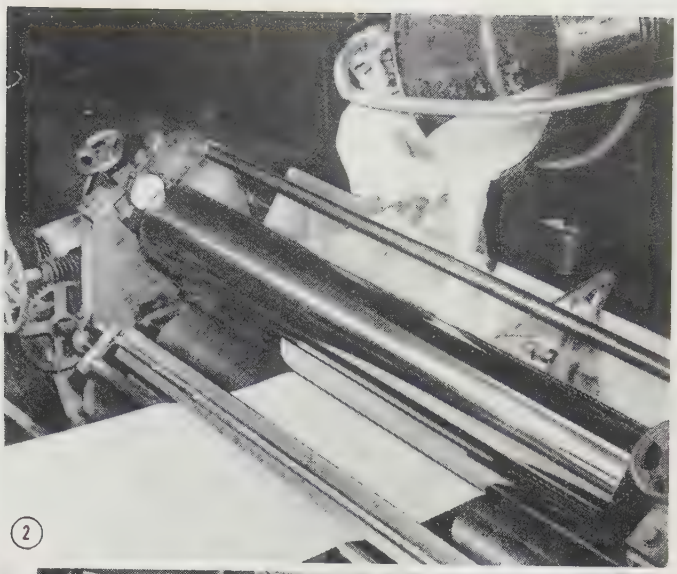
Savings in chemicals and adsorbents can vary from 10% to 50%. Example: a given amount of coagulant removes more turbidity, color and algae in the Precipitator, because of the action of the suspended sludge in the mixing zone combined with the upward flow sludge filtration.

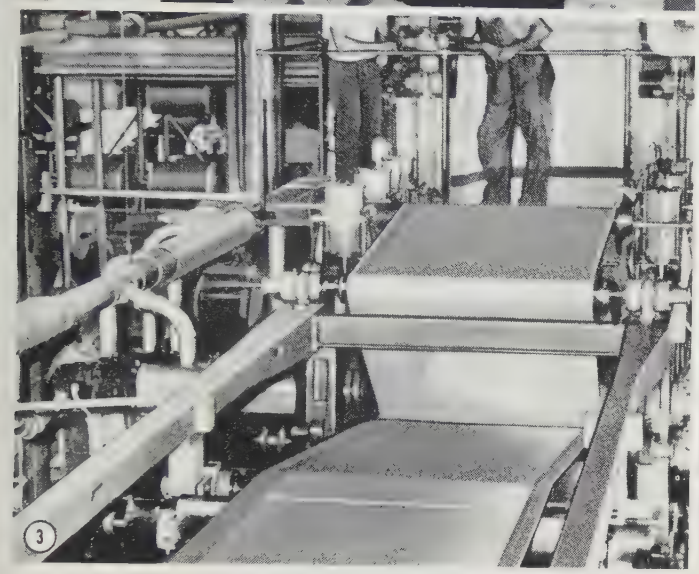
20-Page bulletin explains

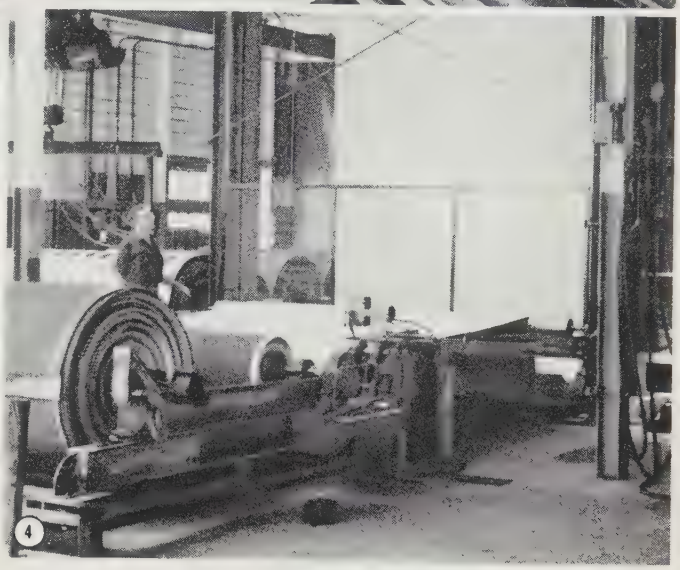
Like Kodak, you may be faced with a need for big-volume, high-purity water. For full details on the Permutit Precipitator, write for our 20-page Bulletin 2204C. No obligation. Permutit Division, Dept. TA-91, Pfaudler Permutit Inc., 50 W. 44th St., New York 36, N.Y. (In Canada contact the Permutit Company of Canada, Toronto.)

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes







They're getting profit ideas on paper with Goodyear latices

Big news-makers in the paper industry are the special products being developed to do special jobs. Like making a stronger, more oil-resistant gasket. (1) Or toughening up tape. (2) Or making dielectric sheets more solvent-resistant. (3) Or printing full-color flooring patterns 100 times sharper. (4) And to do these jobs, paper manufacturers are turning to Goodyear latices.

Want to give your paper improved body, drape, strength and dimensional stability—greater flexibility and softness—outstanding resistance to wear and aging? Then Goodyear latex is the answer.

To simplify selecting them, Goodyear offers four basic types: PLIOLITE *Latex* in two forms (as a rubber or resin dispersion), PLIOVIC *Latex* (dispersion of vinyl copolymer resin), and CHEMIGUM *Latex* (dispersion of nitrile rubber). Each can be used alone—in combination with another—or as a modifier in your present materials. For the finest in technical help on latices, including the latest *Tech Book Bulletins*, write Goodyear, Chemical Division, Dept. I-9432, Akron 16, Ohio.

PLIOLITE
PLIOVIC
CHEMIGUM

Lots of good things come from

GOODYEAR

CHEMICAL DIVISION

Chemigum, Pliolite, Pliovic—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

BETTER UTILIZATION OF TECHNICAL MANPOWER

The Need for Conservation of Technical Personnel

WILLIAM G. TORPEY

THREE factors are accelerating a high national demand for American scientific and engineering skills. These factors are the national defense effort, an expanding economy and the needs of developing nations.

1. *National Defense Effort.* Our military strength is fundamentally dependent upon the maintenance of a technological superiority over any potential enemy. Our Nation must create additional defense weapons and at the same time develop countermeasures against any enemy's weapons. Charts in the public press or magazines which show families of missiles illustrate, in a simple way, the technological complexity required by but one facet of our national defense effort.

2. *An Expanding Economy.* An expanding economy requires continuous improvements in technology to produce the goods and services essential for our citizens. These needs range from new developments in the peacetime use of atomic energy to more practical applications of automation. Within the context of an anticipated economic expansion, industries which are major employers of scientists, engineers, and technicians are expected to be among those industries growing most rapidly.

3. *The Needs of Developing Nations.* Many developing nations are seeking some of the better things of life which we enjoy. Such nations want technological know-how to make the fruits of technology available to the lesser privileged peoples in their countries. It is in the national interest that greater use be made of American technical knowledge in order to strengthen developing countries. The Act of Bogota adopted at the 1960 Economic Conference of the Americas—funds for which President Kennedy urged in his State-of-the-Union Message—illustrates the opportunity for the application of our technical skills in but one area of the free world.

THE OUTLOOK

Against these factors causing an accelerated demand for qualified scientists, engineers, and technicians, we must consider the problem of supply of qualified technical personnel. The roots of the problem lie in the fact that as a Nation we are endeavoring to service the high birth rate population of the 1940's with the low birth rate population of the 1930's. Reference is made to an analysis contained in a report prepared by President Eisenhower's Committee on Scientists and Engineers, a group of 19 presidents of 19 national nongovernment organizations (including the American Society for Engineering Education, the Engineer's Joint Council, the U. S. Chamber of Commerce, the National Association of Manufacturers, the Scientific Manpower Commission, and the American Association of Land Grant Colleges and State Universities), each of which is directly concerned with technical manpower in the United States.

The committee found that there will be continued difficulty in meeting the demand for qualified scientists and engineers during the next 5 to 10 years while the Nation reaps the thin harvest of the low birth rate of the 1930's. The extreme low birth rate occurred between 1932 and 1940 after which a gradual increase began. This increase reached a new plateau after World War II. Thus, the college-age population is now and, for a few more years will continue to be, affected by the low birth rate of the 1930's. The fact is that between 1940 and 1955 the population 18 to 21 years of age declined by over a million (from 9.7 million to 8.6 million). The number in this age group recently began to rise but at the present time the number only approximates the level of the early 1940's.

As this "lean generation" completes college and moves into gainful employment, there will be, by 1965, a numerical decrease from 1955 of almost three quarters of a million in the number of men age 25 to 34 in the labor force. This is the age group on which our Nation relies for young scientists and engineers. Similarly, in the decade 1965–75, our Nation will face an absolute decrease in the number of men 35 to 44 from whom we draw our young executives and project leaders.

This situation imposes a practical limit on the number of young men qualified for professional achievement in science and engineering who can be trained for those fields. The proportion of such men entering college, however, has increased rapidly in recent years and the 1965 number in the 25 to 34 year age group holding degrees in science and engineering will be substantially greater than in 1955. During the 5-year period ahead, women are expected to comprise a constantly increasing proportion of the labor force. Of the total labor force growth of about 10 million expected by 1965, women will account for over half. The proportion of women receiving college training, however, has been far less than that of men; the number of women trained in science is very small and the number of women taking engineering training is almost negligible.

THE CHALLENGE

The current and anticipated lack of qualified scientists, engineers, and technicians, in the face of a rising national demand, leads inevitably to the conclusion that the United States must make maximum utilization of the technical talent already available.

Numerous key officials in industry, government, and education have stressed that positive steps to obtain maximum utilization of currently available scientists, engineers, and technicians offer almost the only immediate solution to the problem of the national demand for scientists and engineers. It has been stated, for example, that, if we, as a nation, could improve the utilization of our current supply of scientists and engineers by only 5%, we would thereby add to the effective professional force as much as all the college graduates who will complete their training in one year.

The term "utilization" or "conservation" does not embrace merely a single specialized type of industrial or agency effort. Rather, utilization refers to the sum total of several personnel activities. Thus, the use of engineering technicians, plans for providing a planned transition from the status of the individual as a new college graduate to his status as a creative or productive professional employee, parallel incentive systems for supervisory and nonsupervisory professional personnel—these are among the components which make up the area to be considered by employers and are points of emphasis in our panel session today. Such consideration should be of benefit, not only to the nation, but also to employers who are mem-

WILLIAM G. TORPEY, Consultant, Executive Office of the President, Office of Civil and Defense Mobilization, Washington, D. C.

PURE TITANIUM DIOXIDE

RUTILE *and* ANATASE

Let us send you samples

R. T. VANDERBILT COMPANY, INC.

230 PARK AVENUE · NEW YORK 17, N. Y.

bers of TAPPI and to individual scientists and engineers employed by TAPPI members.

THE UTILIZATION CONFERENCE PATTERN

The President's Committee on Scientists and Engineers sought to coordinate and stimulate the Nation's efforts to meet growing needs for qualified scientific and engineering manpower. One important phase of the total program of the committee has been the utilization conference program. Specifically, the committee adopted a plan calling for a series of local utilization conferences to be held throughout the United States. The purpose of such conferences has been twofold: (1) to permit an interchange of ideas on specific policies and methods which promote optimum utilization of scientific and engineering personnel among individuals representing Government agencies, industry, and educational institutions, and (2) to stimulate self-analysis and subsequent "follow-through" action by conferees having manpower responsibilities. A total of 19 conferences were held under the committee's auspices during the period September, 1957–December, 1958.

Incident to the termination of The President's Committee on Scientists and Engineers on Dec. 31, 1958, the utilization program of the committee was transferred to the Executive Office of The President, Office of Civil and Defense Mobilization, where the program has been continued. Since 1959, 21 such conferences have been held under OCDM auspices; several more are planned for the next few months.

The Manpower Area of OCDM has the responsibility for directing and coordinating the development of peacetime readiness programs and emergency plans for the proper utilization and control of the manpower resources of the Nation under various emergency situations. To carry out this responsibility requires a manpower organization in place and ready, an adequate knowledge of our present and potential manpower supply and requirements, and action to eliminate or reduce present and foreseeable shortages of manpower. The utilization conference typifies action through responsible local groups and organizations to eliminate or reduce actual or potential shortages in scientific and engineering manpower fields.

From the viewpoint of the total conferences held thus far, written evidence obtained by various planning committees during the follow-up indicates that (1) many companies and agencies are seriously considering recommendations made during the utilization conferences with the objective of direct application, and (2) specific changes have been made in policies and practices of particular organizations, with respect to the utilization of engineers and scientists, as a result of the conferences. Specifically, 34% of the respondents to follow-up questionnaires sent to participants of previous conferences, approximately 6 months after the individual conference was held, have reported that they had made specific changes in their policies or practices as a result of the individual conference. Other conferees have written to planning committees that conference utilization points backed up company policies which they had already instituted.

CONCLUSION

In view of the role of technical personnel in the pulp and paper industry, the planners of this annual meeting believed that a brief review of the national manpower situation and an explanation of three of many practices stressed at previous utilization conferences which may have application to your own organizations may be useful to you. Now that the national manpower situation has been reviewed, each of the next three speakers will discuss one significant practice which has been adopted by numerous employers of technical personnel elsewhere and which may have application in your own organization.

There are two points which I wish to stress: (1) the need for follow-up on the part of participants after this conference is over, and (2) the desire of the Manpower Area to learn of specific company or agency utilization techniques or practices which are proving, or have proved, helpful in promoting better utilization of technical personnel.

We here do not view this session as the end in itself; rather, we regard the session as a vehicle for stimulating action on your part. The success of our efforts here will really be measured in terms of subsequent concrete actions taken by individual conferees after a self-analysis of company or agency manpower policies and programs, in the light of the total session discussion.

One aim of the Manpower Area is to disseminate to pertinent groups information describing helpful company practices or procedures which foster maximum utilization of scientific and engineering skill. We, therefore, will appreciate your alerting us to particular company utilization practices, such as an effective incentive program or professional training program, which may be helpful to other industries, government agencies, and educational institutions.

Through sessions such as this we sincerely believe that significant progress is being made in the conservation of technical manpower.

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

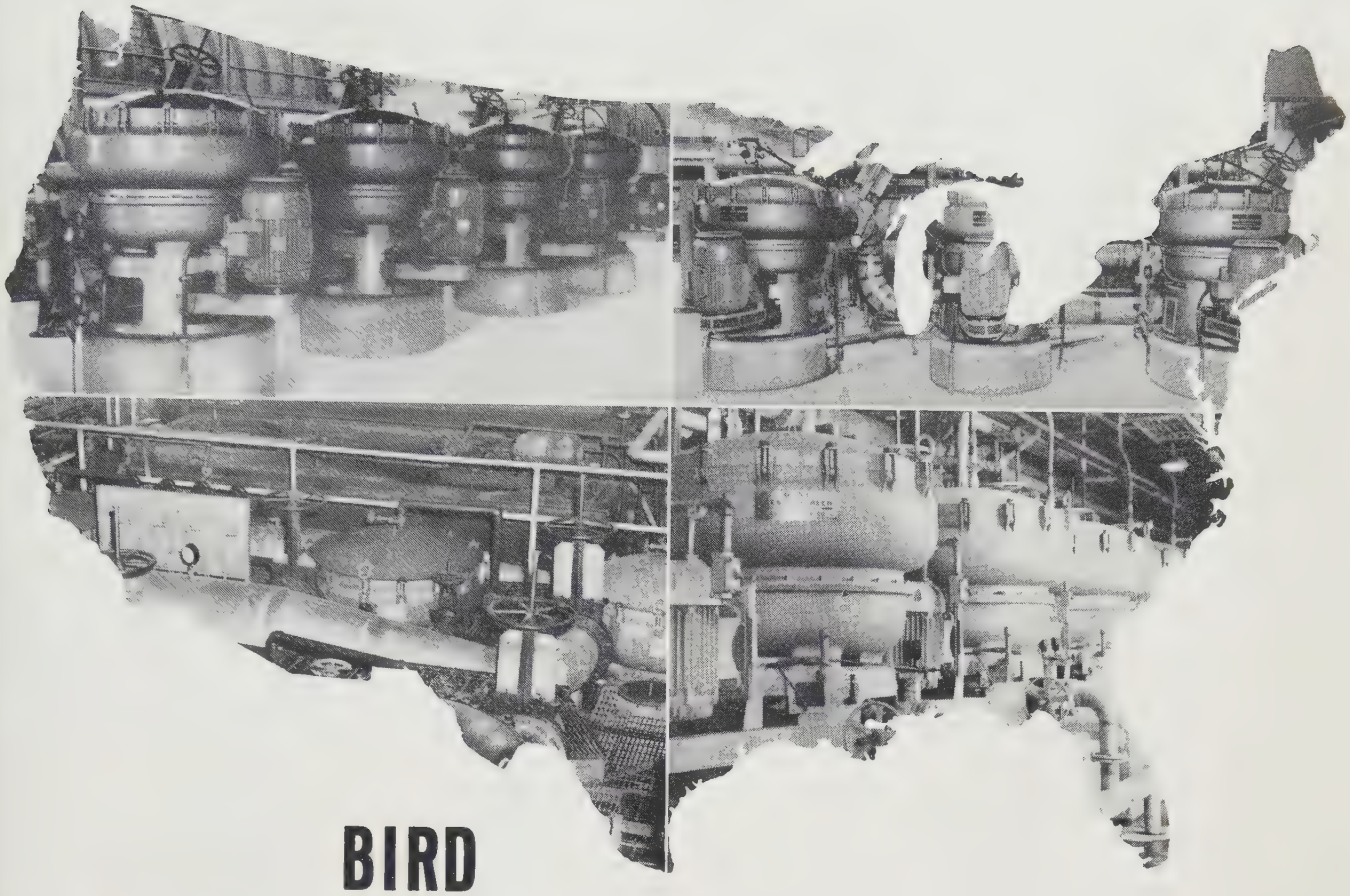
The Developing Role of the Technician

H. RUSSELL BEATTY

It is indeed a pleasure for me to be here this morning to discuss with you the developing role of the technician. It is most appropriate for a talk of this kind to be given at a conference on utilization of scientists and engineers, for only through an expansion in the number of technicians, can we obtain scientific and technical manpower in sufficient quantities to satisfy our needs over the next 10-year period. Too often we anticipate our manpower needs on the basis of short run considerations rather than take the long view. This we cannot afford to do now, for Russia is developing a scientific and engineering manpower team well supported by technicians which they can use to help them win a cold war if not a hot one. Not only are they using this talent in an attempt to win the weapons race, but also to assist underdeveloped nations all over the world and thus add them to their communist bloc. We cannot afford to waste our present supply of engineering and scientific talent and must do everything possible to expand the supply, improve the quality, and increase the effective utilization of this talent.

But, you ask, what is a technician and what can he do? Engineering technicians are usually the product of technical institutes although many have been educated for their work in company operated schools, in military programs, and even through on the job training programs. However, those who come from the technical institute are generally better qualified for their special functions than those obtained through other means. Technical institutes offer 2-year college-level engineering type programs which generally lead to an Associate in Engineering or an Associate in Science degree. The graduates are semiprofessional people qualified to become members of the engineering team in research departments, design rooms, production departments, service staffs, and sales forces. The engineering technician is a member of the engineering team just as the medical technician is a member of the medical team. This is the reason why technical institute curricula are accredited by the Engineers Council for Professional Development, the same body that accredits engineering colleges.

H. Russell Beatty, President, Wentworth Institute, Boston, Mass.



BIRD CENTRISCREENS

are sweeping the Pulp and Papermaking Continent

The Centriscreen installations pictured are only a suggestion of the number and variety that are now on the job in both pulp and paper mills.

You owe it to your stock — and your stockholders — to find out what *centriscreening* can do to help you make better pulp and paper and more of it per day at lower screening cost per ton.

Let us make recommendations, layouts and estimates.

BIRD MACHINE COMPANY

SOUTH WALPOLE, MASS.

REGIONAL OFFICES: EVANSTON, ILLINOIS
PORTLAND 4, OREGON • ATLANTA 9, GEORGIA

Canadian Manufacturers of Bird Machinery
CANADIAN INGERSOLL-RAND COMPANY, Limited, Montreal

The engineering technician is the liaison man between the engineer and the craftsman; the master sergeant of industry, if you please. He has acquired the vocabulary of the engineer and scientist, understands the basic principles of the fundamental sciences which are common to both the professional and semiprofessional aspects of engineering and science and is able to supervise and assist the skilled worker in the production and construction of engineering works. He interprets the engineer's designs to the craftsman so that the product can be built economically. He supervises the craftsman in the construction of buildings, roads, machines, electronic devices, missiles, transportation equipment, and the like. He works with the engineer and scientist in the research laboratory on the construction of experimental models of new devices. He frequently is employed as a "customer engineer" to service computers and other complex electronic devices or as a Civil Aeronautics Authority licensed Aircraft Technician, who makes sure that commercial airliners are safe to fly before they take off.

The engineering technician can serve effectively in many other ways. It is very difficult to keep a professional engineer "on the board" in drafting and design for more than a year or two. Engineering technicians are happy to make this work their life-time career. They frequently are employed in production work as methods men, production planners, tool designers, plant layout men, and supervisors. Engineering technicians also make excellent salesmen, if they have the necessary sales personality. Frequently, engineering technicians rise to leadership positions, for leadership ability is more dependent upon personality characteristics and drive than upon the type of formal education pursued. At least two thirds of the work being done in the engineering departments of manufacturing plants can be done as well, if not better, by engineering technicians. Engineering managers would do well to study their engineering tasks and utilize the principle of the division of labor so that professional engineers and scientists are used on work requiring professional ability and technicians on work requiring semiprofessional ability.

Our engineering and scientific manpower problems can be solved only by the better utilization of the various members of the engineering team—the scientists, the engineers, the engineering technicians, and the craftsmen. Each has an important contribution to make to the success of any engineering or scientific undertaking. All are in short supply viewed from the long run demand viewpoint. However, there are more men with the aptitude to become engineering technicians than to become engineers and scientists. The latter require men with unusual gifts in mathematics. The engineering technician can be successful with only average mathematical ability, providing he persists in the study of mathematical and scientific subjects. He must, however, have mechanical sense as well as an interest in technical things which will enable him to be practical in his approach to engineering problems. He must also have the will to work hard for he will be subjected to the same educational mental discipline for 2 years that the professional engineer and scientist has been exposed to for 4 or more years.

Now that we have defined the engineering technician in terms of the services which he can render, let us analyze the long run supply and demand aspects of this manpower problem. Some time ago, Dr. Howard Bevis, then chairman of the President's Committee on Scientists and Engineers, had this to say and I quote:

"The President's Committee recognized the shortage of technicians at its very first meeting. The Committee, from information available to it, concluded that the shortage of technicians in many areas is probably even more severe than the shortage of scientists and engineers. The Committee was alarmed at the fact that our Nation in its technical institutes and junior colleges produced about one technician for every two or three engineers. I have no magic number of what this ratio should be, but available information in our country and our industrialized friendly nations leads me to believe that the ratio should be reversed. I do not mean that fewer scientists and engineers should be produced; rather, many more well-trained technicians are needed today and will be needed in the future."

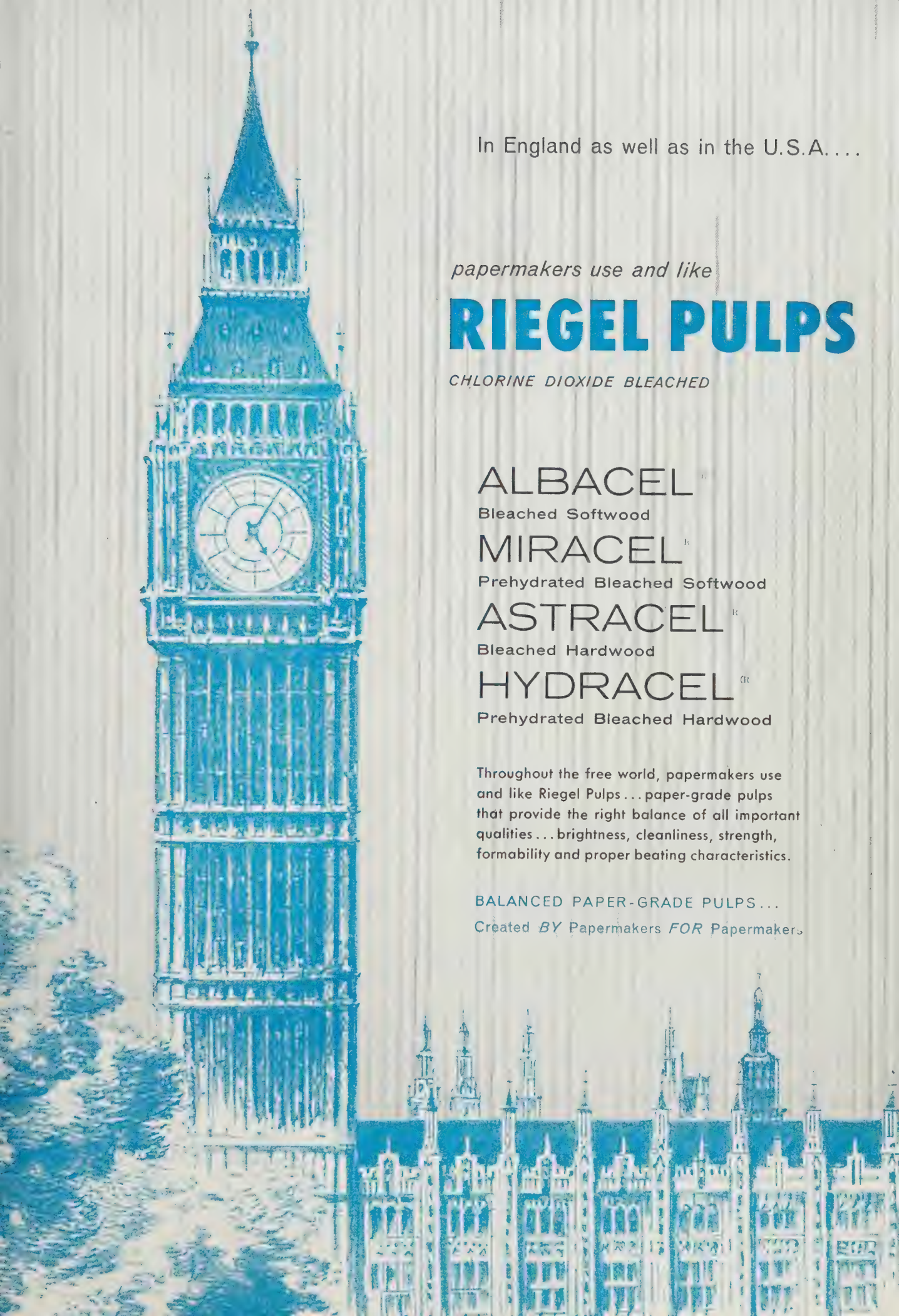
From a recent study by the United States Office of Education, we find that in 1956 there were enrolled in technical institute education in the United States, 57,622 students in both day and evening programs and that 11,742 were graduated from such courses in that year. Approximately 30,000 were graduated from our engineering colleges with bachelor's degrees in this same year or a ratio of 0.4 of a technician for every engineer.* In a study by the Engineering Manpower Commission of Engineers Joint Council of employment of technicians by government and industry, it was found that the ratio of technicians to engineers in the sample used was 0.7 to 1, slightly more than half of whom were graduates of technical institute courses. It is apparent that American industry and government has not yet found it necessary to utilize technicians to the fullest extent possible in performing scientific and engineering functions. Most students of the subject agree that a ratio of two or three technicians per engineer should be the minimum for best utilization of our professional talents. We have a long way to go to reach such a utilization goal. But until we do, our engineers and scientists will be burdened with tasks that could be assigned to the technician, and the compensation for such services will reflect this fact.

Industry has much to do in preparation for better utilization through the expanded use of technicians. They will need to analyze their engineering tasks to determine how best to use the talent of each member of the team. They will need to develop orientation programs for the technician similar to those which they have developed and are developing for engineers. These should include the opportunity for further study and personal development. Care should be exercised that the technician is not considered a second rate citizen. Status barriers and lack of prestige will reduce the effectiveness of his services to any organization.

We must be careful to maintain high quality in the engineering technician of the future as we undergo a rapid expansion in this form of higher education. I cannot help but review with concern the growing interest in this form of education by the vocational divisions of our state education departments under the impetus of Title VIII of the National Defense Education Act. If post secondary technical education is offered in vocational schools throughout this country, we shall increase our supply of technical manpower, but probably at a quality below the minimum for good results. This could greatly handicap the healthy growth of high quality college level technical institute programs.

What will be the future of technical institute education in America? I believe it will expand in keeping with the needs of our society. I predict that it will increase at a much faster rate as engineers and scientists realize that they can more effectively utilize their special knowledge and skill by the more extensive use of technicians and thus increase their own value to society. I am convinced that we shall turn out six to ten times the number of engineering technicians in 1970 that we turned out in 1956. The improved acceptance of the engineering technician by his professional brethren, by industry and government, and by the public in general should enable those engaged in this form of education to raise the necessary funds for financing the required expansion. The long run shortage of talent for the engineering and scientific professions can handicap us only if we fail to develop fully the resources of the much larger group with the talent to become technicians. I am confident that the developing role of the technician is becoming more apparent to all as a solution to our en-

* In 1960, we graduated 16,000 from our technical institutes and 38,000 from our engineering colleges, or a ratio of 0.4 of a technician for every engineer.



In England as well as in the U.S.A. . . .

papermakers use and like

RIEGEL PULPS

CHLORINE DIOXIDE BLEACHED

ALBACEL®
Bleached Softwood

MIRACEL®
Prehydrated Bleached Softwood

ASTRACEL®
Bleached Hardwood

HYDRACEL®
Prehydrated Bleached Hardwood

Throughout the free world, papermakers use and like Riegel Pulps . . . paper-grade pulps that provide the right balance of all important qualities . . . brightness, cleanliness, strength, formability and proper beating characteristics.

BALANCED PAPER-GRADE PULPS . . .
Created *BY* Papermakers *FOR* Papermakers

gineering and scientific manpower problem. We need to work together to make sure that this development produces the quality as well as the quantity of technicians that we require.

In conclusion, I would like to emphasize the following points:

1. The engineering technician is an essential member of the engineering team.
2. As we move more toward the development of the engineering scientist in our 4-year engineering college, we create a greater need for the engineering technician's services in work formerly done by the engineer.
3. There is a greater shortage of engineering technicians than there is of engineers, and frequently engineers are required to do technicians work because of this fact.
4. Engineer's wages reflect this fact.
5. The solution to our technical manpower problem is as follows: (*a*) an expansion of technical institute education but not at the sacrifice of quality, (*b*) an improvement in the quality of engineering education, and (*c*) better utilization of talents of both engineers and engineering technicians.

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

The First Five-Year Plan of the Engineers Joint Council for Professional Development

JOHN GAMMELL

As MOST of you know, the ECPD is a conference of engineering bodies, organized to assist in and to advance education for engineering and to further the intellectual development of individuals who are or may become engineers.

The participating bodies are the American Society of Civil Engineers, the American Institute of Mining, Metallurgical, and Petroleum Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Society for Engineering Education, the American Institute of Chemical Engineers, the National Council of State Boards of Engineering Examiners, and The Engineering Institute of Canada.

As stated in their charter, I quote

> "The exclusive purpose of ECPD shall be to advance and promote scientific and engineering education with a view to the promotion of the public welfare through the development of better educated engineers."

Let me give you some data on the Committee on Development of Young Engineers of which I am currently chairman. There are 31 members representing the founder societies. There are six subcommittees on six major points:

1. Career orientation
2. Continuing education
3. Professional identification
4. Responsible citizenship
5. Selected reading
6. Self-appraisal

Plus five implementation committees

1. Before graduation
2. Within participating societies
3. On a community basis
4. On an industry basis
5. On a public utility basis

This committee (CDYE) has distributed in the last year (1959–60) approximately 26,000 First Five Year brochures to approximately 60 colleges, 16 major industral concerns and the technical societies.

JOHN GAMMELL, Director of Professional Development, Allis-Chalmers Mfg. Co., Milwaukee Wis.

Four hundred and fifty-seven copies of a "Manual of Community Implementation" have been distributed—mostly to chairman of local chapters of technical societies.

Approximately 2400 FFY kits have been distributed. These kits contain the "Canons of Ethics for Engineers" which should be framed in every engineer's office. If there is anything top men should have in common, it is integrity. There is also included the "Faith of the Engineer." Let me read the 1st and the 5th paragraphs from the "Faith of the Engineer":

> "I am an engineer. In my profession I take deep pride, but without vain glory; to it I owe solemn obligations that I am eager to fulfill."

and now the 5th paragraph:

> "Since the Age of Stone, human progress has been conditioned by the genius of my professional forbears. By them have been rendered usable to mankind Nature's vast resources of material and energy. By them have been vitalized and turned to practical account the principles of science and the revelations of technology. Except for this heritage of accumulated experience, my efforts would be feeble. I dedicate myself to the dissemination of engineering knowledge, *and, especially to the instruction of younger members of my profession in all its arts and traditions.*"

The kit also contains "A Professional Guide for Young Engineers," which is a selected group of papers by the late W. E. Wickenden, including the famous "Second Mile" essay, the theme of which is based on the familiar Biblical quotation, "Whoever shall compel thee to go one mile—go with him twain." It has a "Selected Reading List," a "Personal Appraisal" form, and the "First Five Years" brochure.

We have a new manual (prepared by N. W. Dougherty, Dean Emeritus of the University of Tennessee Engineering School). It is entitled, "Your Approach to Professionalism" and has the following Table of Contents:

I. Characteristics of a Profession and a Professional
II. A Specialized Body of Knowledge and Skill
III. Ethical Practice
IV. Threats to Independent Action
V. A Service Motive and a Relation of Confidence
VI. Legal Status
VII. Engineering Unity
VIII. Instruction in Professionalism
IX. Responsibility of Industry
X. The Place of the Engineer (Now and in the Future)

I commend it to you as not only being highly valuable but highly readable too.

The problem that confronts us is indicated by the fact that we have 750,000 engineers in the United States who are in danger of becoming progressively obsolete. They have had an engineering education. Its one-half life is estimated at 15 years. This is a deterioration of 3% a year, or 22,000 engineers per year equivalent are lost if we do not have a major retreading procedure. In addition, we have to teach young engineers their job, their position in the community, and in the profession, and what their responsibilities are in these areas. If we don't do these things, Russia gets ahead of us —more immediately the salary compression factor continues—we don't get a raise. Of what good is 30 years' experience in a wagon or buggy plant if you want to get to the moon. Young men are bid up because their up-to-date technical knowledge makes them worth more. To keep our engineers growing is a colossal task.

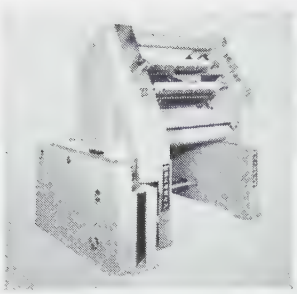
What is the challenge?

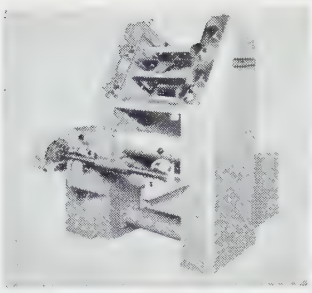
In college a man learns much that's new every day. The intellectual excitement is great. After college there are many routines. Progress is not always predictable. Rewards are not immediate or as satisfactory as, for instance, grades and honors in school.

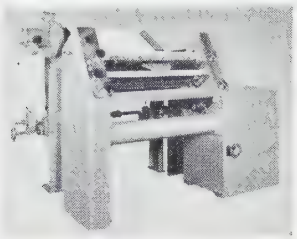
Let me illustrate. When you start college you know what you have to do. The 4-year curricula is clear. When you go to class you know what you have to do. If the class is

A white package speaks for itself when it contains Unitane® titanium dioxide. The exceptional opacity and whiteness of Unitane add sparkle, brilliance and superb printability... make packages come alive with all the persuasive sales appeal that modern marketing demands. Unitane offers exceptional production advantages, too. Easy dispersion, effective water suspension, high hiding, retained whiteness...all are yours with Unitane. Ask your Cyanamid Pigments representative for details. Call him today. Whiter and brighter with Unitane. CYANAMID

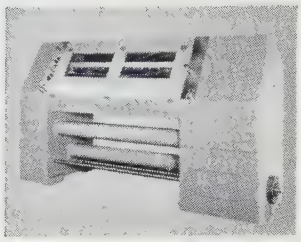
AMERICAN CYANAMID COMPANY · PIGMENTS DIVISION · 30 ROCKEFELLER PLAZA, N. Y. 20, N. Y.



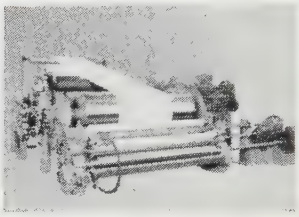


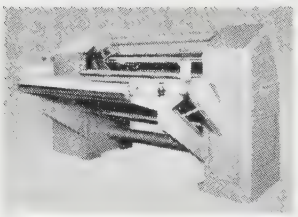


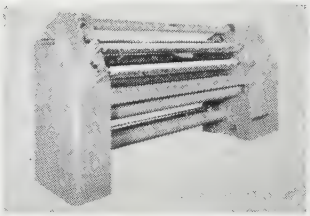
Gummed Paper
Vinyl Coating
Hot Melt



Foam Casting
Chart Paper
Solvent Coating







Adhesive Tape
Film Casting
Magnetic Tape

PRECISION

reverse roll coating machines

More Waldron reverse roll coaters are used in more applications than all other makes combined.

Complete coating installation including web handling, ovens, embossers and laminators are engineered and built by experienced and skilled technicians.

A full range of standard 3 roll and 4 roll designs from "pilot plant" size to 154" widths are available. Write for specifications.

Laboratory facilities are also available for your use in evaluating Waldron equipment.

WALDRON

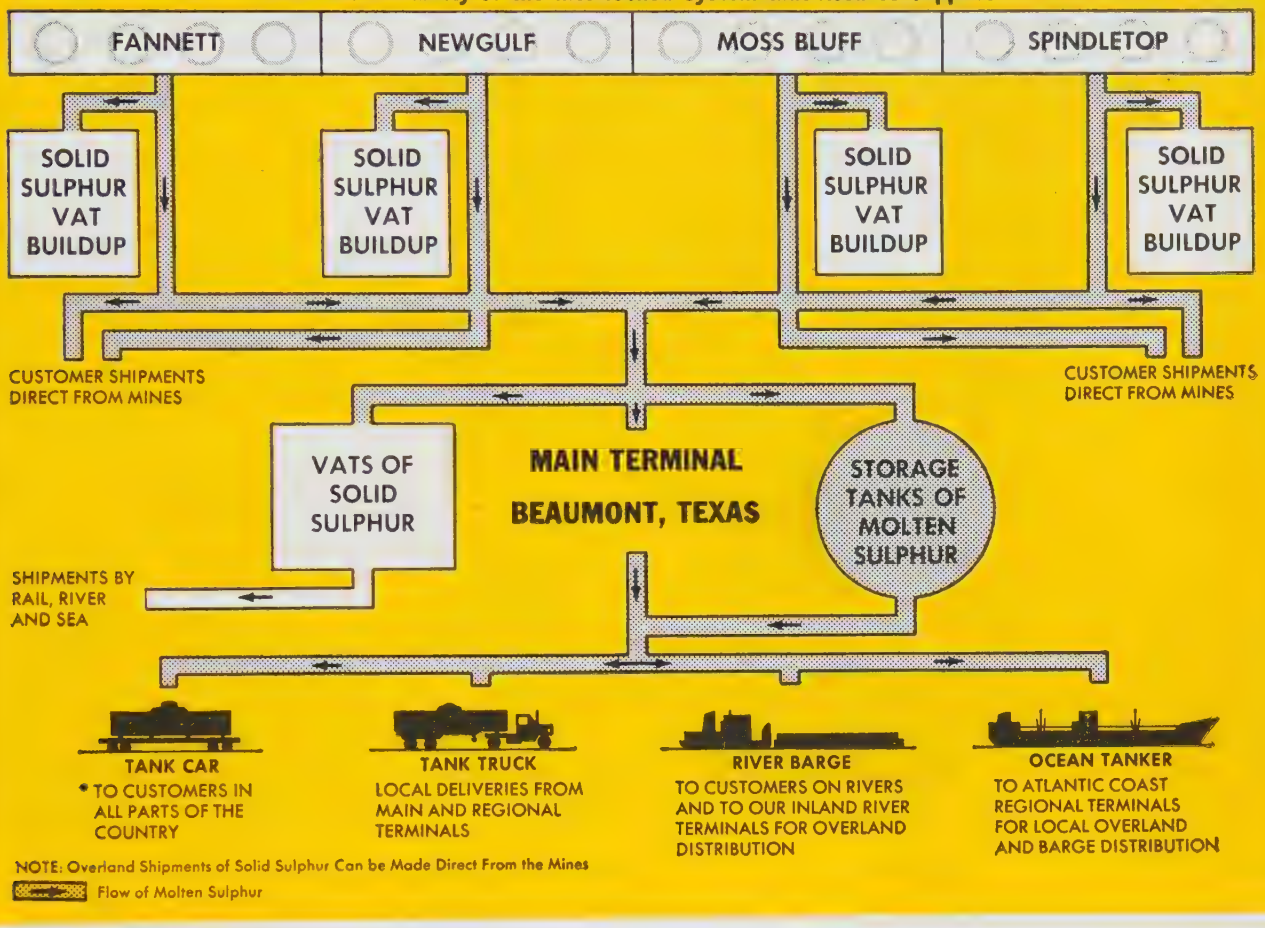
technical competence in web process machinery

WALDRON-HARTIG, Box 791, New Brunswick, N. J./a division of Midland-Ross Corporation MR

molten sulphur

HOW TGS MOLTEN SULPHUR TRAVELS FROM FRASCH MINES TO CUSTOMERS

—Note the Flexibility of the Interlocked System that Assures Supplies—


FANNETT
NEWGULF
MOSS BLUFF
SPINDLETOP
SOLID SULPHUR VAT BUILDUP
SOLID SULPHUR VAT BUILDUP
SOLID SULPHUR VAT BUILDUP
SOLID SULPHUR VAT BUILDUP
CUSTOMER SHIPMENTS DIRECT FROM MINES
CUSTOMER SHIPMENTS DIRECT FROM MINES
VATS OF SOLID SULPHUR
MAIN TERMINAL
BEAUMONT, TEXAS
STORAGE TANKS OF MOLTEN SULPHUR
SHIPMENTS BY RAIL, RIVER AND SEA
TANK CAR
• TO CUSTOMERS IN ALL PARTS OF THE COUNTRY
TANK TRUCK
LOCAL DELIVERIES FROM MAIN AND REGIONAL TERMINALS
RIVER BARGE
TO CUSTOMERS ON RIVERS AND TO OUR INLAND RIVER TERMINALS FOR OVERLAND DISTRIBUTION
OCEAN TANKER
TO ATLANTIC COAST REGIONAL TERMINALS FOR LOCAL OVERLAND AND BARGE DISTRIBUTION
NOTE: Overland Shipments of Solid Sulphur Can be Made Direct From the Mines
Flow of Molten Sulphur

Flexible Facilities to meet a Growing Demand

The rapidly growing demand for deliveries of sulphur in molten form—and it is coming from all parts of the country—is well-answered by the flexibility of our production, storage and distribution facilities.

Here, graphically, is the way TGS Molten Sulphur moves from the four Frasch Process producing areas in Texas to customers. Unusual flexibility enables us to do several things simultaneously. We can fill orders direct from the mines, build up inventory at our main terminal in Beaumont, Texas, ship to customers from this main terminal or supply our regional terminals.

We maintain steady production schedules at all properties. With flexible storage, shipping and delivery facilities of not only molten sulphur but solid sulphur, we are in a strong position to serve the sulphur-consuming plants all over the United States and Canada.*Our sulphur recovery plants (from natural gas) in Wyoming and Alberta take care of the demand in northwest United States and Western Canada for both molten and solid sulphur.

TEXAS GULF SULPHUR COMPANY

75 East 45th Street, New York 17, N. Y.
811 Rusk Avenue, Houston 2, Texas
Sulphur Producing Units: Newgulf, Texas • Moss Bluff, Texas • Fannett, Texas • Spindletop, Texas • Worland, Wyoming • Okotoks, Alberta, Canada

COLOR-EYE® Colorimeter—in use at the Fitchburg Paper Co.

The Fitchburg Paper Company, prominent manufacturer of fine paper, relies on three Color-Eye colorimeters, at different plant locations, for matching color and for testing brightness of white paper. Exacting standards must be met before any paper is allowed to leave the plant, and Color-Eye helps maintain these quality requirements.

Color-Eye is a dual purpose instrument, combining a colorimeter and an abridged spectrophotometer. By using this unique combination of measuring techniques, Color-Eye can be used for matching production colors with color standards, formulating color standards, and even conducting special analytical research.

You can put Color-Eye to work in your plant. To discover how Color-Eye is aiding others, write for Bulletin CE1160.

IDL®

INSTRUMENT DEVELOPMENT LABORATORIES, INC.

64 MECHANIC STREET, ATTLEBORO, MASS.

labeled mathematics it will not be concerned with economics, human relations, law, or anything but mathematics. If you work all the problems assigned to you, and if you get them right and get them in on time, you get an A. The rewards are immediate and predictable. But in industry they are not. Raises cannot be given if no money is available and promotions cannot be made if no advancements are needed.

Work is not assigned in the nice orderly fashion we are used to in school. Customers upset schedules, economic cycles change plans. We find ourselves more on our own. We don't clearly know what to do to advance ourselves and some of us do very little. And then, we are tired of studying anyhow. The postcollege slump sets in.

What are some guiding principles to overcome this? What can the profession do about it? Well, we can try and develop a good professional climate wherever engineers work. This climate would involve:

1. Sound utilization practices.
2. Encouragement of registration and technical society participation.
3. Favorable attitudes toward additional education.
4. Proper use of engineering titles.
5. Effective engineering-management communication policies.
6. Sufficient orientation procedure for new job assignees.
7. Good employment practices.

We can lend ourselves to the purposes of counselling and advice to young engineers whenever its helpfulness is indicated.

But ultimately we must impress upon the young, growing engineer that the responsibility for professional advancement has now largely shifted to him. We can only help—we cannot direct as we did in college. The principles of the "First Five Years" program and its literature will aid him.

He needs a planned program. Here are the reminders which will aid him to plan his program. First, he must find a job suitable to his talents and to his motivations insofar as this is possible. Second, he must train himself for this job diligently until he knows it well. Third, he must make plans to keep up—to grow in his job—to advance his job's importance and his importance to it.

Consideration of these six points will benefit him in his program.

An example of Avisco Rayons in Industry

What do you want to filter better?

The new Avisco® rayons have physical, mechanical and chemical properties of importance to the filtration field.

Being man-made, Avisco rayon fibers can be held precisely to the lengths and diameters desired. This facilitates processing—wet or dry—and improves control of porosity, stiffness and bulk of the filter mat.

Avisco rayon has good resistance to most gases, most of the common organic compounds, and inorganic materials with the major exceptions of concentrated mineral acids, hot dilute mineral acids, concentrated caustic alkalies and certain powerful oxidizing agents.

Write for Avisco Technical Bulletin G-15, containing properties, applications and samples of filter webs made of Avisco rayon. Use the Quick Reply Coupon at right.

QUICK REPLY COUPON 9-7

Industrial Merchandising Division
American Viscose Corporation
350 Fifth Avenue, New York 1, N.Y.

Please contact me about Avisco Rayons for use in the following application:_____

Name_____

Company_____

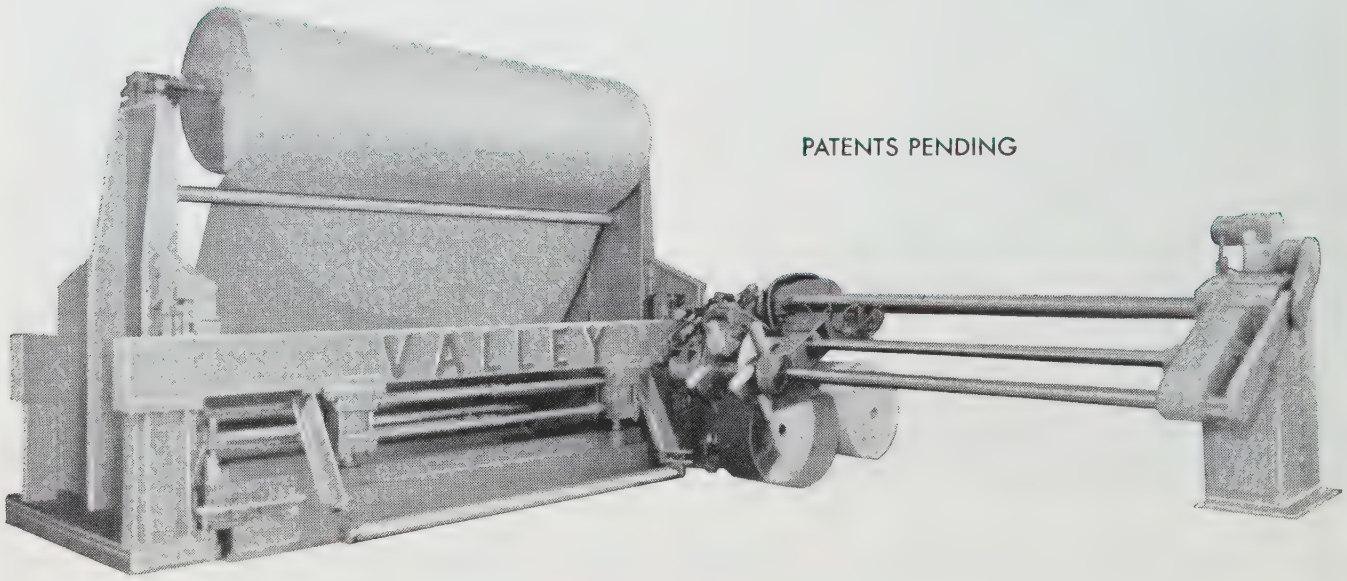
Address_____

City_____ Zone____ State_____

AVISCO® RAYON

AMERICAN VISCOSE CORPORATION, 350 Fifth Avenue, New York 1, N. Y.

NEW and REVOLUTIONARY



PATENTS PENDING

wraps smoothly . . . faster . . .
with minimum supervision . . . in
smaller floor area . . . at lower cost

Each phase of automatic time cycle can be individually activated by turning control console selector switch to manual, and pressing individual operation pushbutton mounted on the console board.

. . . ROLL-WRAPPING SYSTEM

wraps a roll AUTOMATICALLY in less than 1 minute!

ANOTHER VALLEY FIRST! Now . . . a completely automatic, flexible *right angle* packaging system. Cuts wrapping paper to required size without manual settings, wraps and crimps ends ready for gluing on headers (Can be varied to use inner heads only — combination of inner and outer heads — or an outer head only). Wraps single or multiple ply including vapor seals. Unique console-control system shown will wrap paper rolls of varying sizes, one after the other in face lengths of from 7″ to 112″, and 15″ to 42″ diameters (These are *not* limiting dimensions). Crimper head makes hard, firm, uniform pleat for tight packaging, thereby assuring ultimate consumer of a superior product from your mill. Space-saving system includes conveyors, roll wrapping machinery, glue system, roll headers, scales, crimpers, dispensers and cutters, and lowering devices. Eliminates need for expensive trimming machines, unsightly glue pots, and other inconveniences common to normal wrapping methods.

VALLEY

INQUIRIES CONCERNING SPECIFIC ROLL PACKAGING NEEDS INVITED . . .

by VALLEY IRON WORKS CORPORATION

APPLETON, WISCONSIN
subsidiary of Allis-Chalmers Manufacturing Company

West Coast Representative:
E. A. Berry, P.O. Box 958, Longview, Washington

Canadian Representatives:
Pulp and Paper Mill Accessories Ltd., P.O. Box 850
Saint Laurent, Montreal 9, P.Q. Canada

1. Career orientation
2. Continuing education
3. Professional identification
4. Responsible citizenship
5. Selected reading
6. Personal appraisal

These are the blocks with which he must build.

But the environmental situation is important too. The young engineer is surrounded by an environment involving: (1) his employer and related industry, (2) the engineering and technical societies, and (3) the colleges and universities. Anyone involved in these activities must also do his part. An employer who is striving constantly to improve his people, an engineering society that works hard at having valuable programs, and a university that adapts itself to the industrial needs of its area are assets.

The whole can be greater than the sum of its parts. It may not be geometrically true, but general considerations of life indicate this often. Some great men, some great institutions are great not because of brilliance here and there, but because of no weaknesses—soundness throughout. A great profession requires good societies, good universities, good employers.

Let us go back over the six points. First, there is *Career Orientation.* What is the position of a young man just out of school? Robert E. Doherty, president of Carnegie Tech a number of years ago, states:

> "From personal experience, extending over a decade, in examining and following the professional progress of very large numbers of electrical and mechanical engineering graduates from over a hundred engineering colleges, it is my studied observation that they have acquired at college notable facility in certain routine engineering techniques; that they have in memory a large body of engineering information; that their long drill and experience in careful measurement and numerical calculation have engendered in them a quantitative sense, a profound respect for fact, and habits of thoroughness, orderliness, and accuracy, all of which are distinctive attributes of a scientific, professional mind. However, with all these recognized values, their college courses have left most of them at graduation mentally clumsy, relatively narrow in interest and perspective, and awkward in writing and speech.
>
> Their minds have not been sufficiently disciplined in straight thinking and consequently they are lost when they encounter a problem which does not conform to certain special types. They are practically incapable of analyzing problems or situations in terms of general principles. They think narrowly in terms of special formulae and specific cases. Moreover, under the pressure of time they have not developed a real interest in other vital aspects of life. Without historical perspective, with little knowledge and almost no interest in the thoughts and lives of great thinking men in other fields, engineering graduates have tended to remain in the comparative isolation of technology."

The student has been accustomed to thinking of himself as the center of attention. He has been the center of attention of his family and its reason for existence. The center of attention of his school and reason for its existence. After graduation he discovers he is on the outside and only part of the total activity. He needs a hand.

The student through orientation procedures making him acquainted with his new job routines should be made to feel his broader engineering responsibilities and his very good opportunities to do something about taking care of them. His employer should also be reminded of the rewards which will accrue to him if he does a good job of orientation and training.

Doherty says about these new found job activities:

> "The simple fact is that in providing a training for the routine operations of engineering these programs at the same time have opened the *possibility* for the self-development of these other powers to which I have referred, even if that self-development has had to be achieved against odds and *usually after graduation.* The point is that if the objective is to provide educational preparation for *leaders* in the profession, *then the development of the powers which characterize such leadership should not be left to chance amid difficulties, but should be purposely fostered.*"

Nowhere can purposefully fostered programs be better pursued than through continued education, particularly in local schools. This phase of development needs a careful appraisal of where the young engineer wants to go—then courses to get him there.

It is important that continued habits of going to school start immediately after college and persist for some years. It is important that colleges provide suitable classroom opportunities. Without such a combined effort, the young engineer will not keep up—he will find the compression factor operating in his salary attainments. But he must realize that industry is basically concerned with profits not knowledge. To be valuable in industry the knowledge must be translatable into profits. Coming from a knowledge-oriented world of education this concept may worry the young engineer. Counselling advice and experience should put it in its proper perspective.

Professional Identification. Most who have benefited by belonging to a profession seem inclined to want to pay back the debt. What better means than an identification with the technical and professional societies. To provide an audience where ideas can develop, a means for their publication and discussion, and a meeting place for like minds is surely a privilege. Belong, register, take part.

But professional identification involves more than this. It involves the knowledge and practice of those high standards of citizenship plus such special ethics as may apply to our particular profession. The societies provide discussion opportunities—we should encourage participation.

Plato, many years ago, said about responsible citizenship–

> "The punishment wise men suffer for indifference to public affairs is to be ruled by unwise men."

The question should be asked, "What group anywhere can achieve a status of importance without good citizens?"

The young engineer has been too busy with his education for 16 or more years to have thought much about community affairs, but he must not be left out of them.

Governor Clyde of Utah recently said:

> "The engineer and the scientist play so large a role in our lives, it would be tragic if we failed to include them in our councils of government, and left the critical decisions entirely to non-professionals incapable of fully understanding the age in which we live."

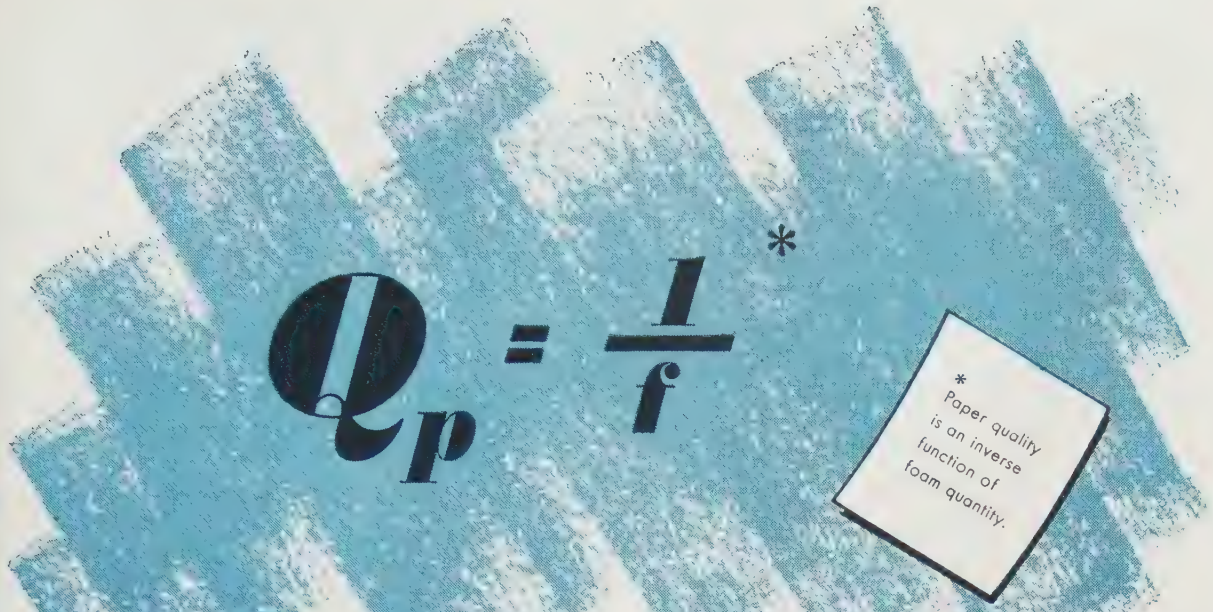
The ECPD has prepared a booklet, "Citizenship and Participation in Public Affairs." It is meant to emphasize the engineer's responsibility to society. It starts off with a manifesto by a great engineer and a great citizen, Herbert Hoover.

As a part of this manifesto he says of engineers—"They should exercise their civic responsibilities with the same devotion with which they discharge the high purpose of their profession."

Selected Reading. What a man does with his leisure time is often the clue to what he really is or can become. What does the young engineer read? Does he know about the best literature in the fields of biography, travel, history, economics, sociology, psychology, philosophy, natural science, and literature? Is the young engineer acquainted with the best in technical writings? Does he know about the periodicals of the national societies and about the industrial magazines?

Introspection can be daydreaming. It can also be a planned stock taking procedure designed to tell you where you are, where you want to go, how to get there?

The young engineer might classify his needs into three areas:



ELIMINATE FOAM—IMPROVE PAPER FORMATION

with **Nalco 71-M**

Effective, easy-to-handle, and economical paper machine antifoam

Better Paper—Faster Production

If stock is trapped in the headbox by a mass of foam, it can't do much for sheet formation. Nor do bubbles on the wire add anything to the quality of your paper.

Such adverse conditions can easily be avoided, however – with Nalco 71-M, a hard-working paper machine antifoam. It is especially designed to improve paper formation by eliminating excess foam under the low pH conditions generally encountered in machine operations.

Nalco 71-M prevents floating stock in the headbox, so that stock which would otherwise be trapped in air bubbles is instead deposited on the sheet to give you better paper formation. On the wire, Nalco 71-M prevents formation of bubbles to eliminate pinholes in the finished paper.

Foam weakens the structure of paper, necessitating slower machine speeds and resulting in more frequent breakage and more down time. Nalco 71-M eliminates foam, allowing higher machine speeds with less down time.

While acting as an effective antifoam and defoamer, Nalco 71-M does not adversely affect either sizing or furnish. It has also been cleared by the U.S. Department of Health, Education, and Welfare, Food and Drug Administration, for use in the manufacture of paper and paperboard for food packaging.

Easy-to-handle and Economical

Shipped in liquid form, Nalco 71-M makes an instantaneous emulsion without stirring—even in water as hard as 400 ppm. Nalco 71-M emulsion is stable, too, and can be prepared in large quantities and stored for long periods of time.

Top-notch cost performance is another characteristic of Nalco 71-M—you can knock down more foam with less antifoam, if the antifoam is Nalco 71-M. In one field evaluation, for example, Nalco 71-M proved more economical to use than did live steam.

The Nalco Way: Quality Chemicals plus the Best in Service

As with all Nalco Chemicals, technical service from your Nalco field representative, backed by the experience and facilities of Nalco's laboratories, is yours with Nalco 71-M. Your Nalco representative can help you analyze your foam problems and find the most efficient application of Nalco's fine antifoams to solve them. For further information on Nalco 71-M, and the other Nalco antifoams made especially for the paper maker, call your local Nalco Representative or write directly to Nalco for details.

NALCO CHEMICAL COMPANY

6216 West 66th Place • Chicago 38, Illinois

Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany
In Canada: Alchem Limited, Burlington, Ontario

Nalco® ***...Serving the Paper Industry through Practical Applied Science.***

Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES
Nalco CHEMICALS
Nalco SERVICES

1. Do I have enough technical knowledge to handle the job I have, or would like to get?
2. Is my business knowledge—my understanding of marketing, costing, labor, finance, law, etc., sufficient?
3. What are my capabilities in the persuasive field of leadership and human relations. Can I get things done through other people?

The ECPD Personal Appraisal form does all this well. It is a series of considered questions arranged in an orderly manner which should be of great aid to many. The headings in the form are:

A. My job
B. My profession
C. My personal development
D. My general program of development
E. My immediate program

As an example, the first three questions under *my job* are:

1. What are the duties and responsibilities of my present position?
2. Have I sufficient knowledge of my duties and the organization I serve to enable me to do my job well?
   How should I attempt to gain additional knowledge?
3. Have I the general education needed to do this job well? If not, what additional education activity should I undertake?

Two of the questions under my profession are:

(22) Is my program of reading adequate to keep me abreast of technological progress in fields which bear on the work of my career?
(25) Am I a good representative of my profession in my community?

Under personal development several type questions are:

(27) Are my education and cultural background adequate for the realization of my ambitions?
   Are my reading habits designed to enhance this background?
   What other methods can I use to improve myself in this area?
(28) What physical, personal, or emotional shortcomings may tend to prevent full realization of my ambitions?
   What steps should I take to overcome these handicaps?

It is felt that industry, if informed, will be much interested. Our work is in the field of triggering ideas. The ideas and the implementation of them must come from the grass roots.

It is a never ending task since the demands on our engineers not only change as they grow older, but change with the development of technology as well.

Thus, as has been said, engineers 0 to 5 years out of school complain that their curricula was not practical enough; 5 to 15 years out of school, it was not theoretical enough; 15 to 25 years out of school, it should have contained more writing and speech training; and 25 years and over out of school, it did not contain enough general culture.

Promote the literature, study it, have meetings when opportunity offers; develop programs in companies and in schools whenever needed. Encourage young men to develop their own programs of reading and study. This is the task—a simple one to state; a hard one to do. (Fellowships—seminars—writing—speaking—magazine subscriptions—night school—community activity where applicable—periodic counselling practices—are a few of the possibilities.)

Now, let me close by quoting from the writings of James Hilton, the creator of that fine literary character, the schoolmaster, Mr. Chips. It is entitled, "The Day Mr. Chips Got Mad" and might be appropriate to this discourse. It starts out with something from Epictetus:

"It is impossible for anyone to begin to learn what he thinks he already knows."

Mr. Chips wasn't often cantankerous, but he did once (and perhaps a bit unfairly) let fly over a letter from a parent containing the sentences: "After my son finishes his education, he will enter my business."

"It was the whole idea of 'finishing an education' that did it. 'Good heavens,' he exclaimed, 'does the fellow think education is like measles—something you get over while you're young so that you don't have to be bothered with it ever afterwards?'" and then came the quotation from Epictetus, as above.

"I daresay Epictetus, like Mr. Chips, exaggerated a little to make a point. But it is a point worth making—that education, in the deepest sense, is continuous and lifelong and in essence unfinishable; and it is true also that what we think we already know is often less helpful than the desire to learn."

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

Parallel Incentive Systems for Supervisory and Nonsupervisory Professional Personnel

C. B. MUNTON

Before proceeding into the text of our discussion of "Parallel Incentive Systems for Supervisory and Nonsupervisory Professional Personnel," I would like to take a few moments to discuss the interest of The National Cash Register Co. in this subject.

The scope of N.C.R.'s research and development ranges from new paper products and paper handling to basic research in chemical and physical phenomena associated with the development of business machine systems. The scientific disciplines represented include engineers of all types, chemists, physicists, mathematicians, and metallurgists, to name but a few. The R & D effort is supported by 609 professional personnel and 266 nonprofessional personnel. In 1960, approximately 3% of gross sales was invested in the research and development program.

Our interest in today's topic is twofold: (1) to protect a sizeable R & D investment by providing the best possible atmosphere for scientific and engineering endeavor, and (2) to continue to maximize the effectiveness of our R & D effort through continued improvement of professional personnel practices.

The subject of the effective utilization of engineers and scientists is timely and is urgent. Technology is moving at an explosive pace. The factor of survival, national or industrial, is associated with how effectively we use one of our most valuable national resources, the scientist or engineer. Our use of scientific personnel will determine our relative position in the competitive market place today and the degree to which we have secured insurance for future growth or survival.

The subject of parallel incentives for supervisory and nonsupervisory professional personnel is an intriguing one for it touches on many phases of research management policies. Like a fine watch, the smooth operation of an R & D organization is an intricate mechanism, a balance of many complex factors, any one of which, when out of adjustment, can affect its utility. In approaching a discussion of this subject, I wish I could state that we at National Cash Register have identified the qualitative and quantitative nature of all these factors and have provided an effective solution to them. Unfortunately, this is not true.

However, let me talk about some of the factors which we have found to be critical in relation to the desire to shift from the scientific ladder to administration, and some of the

C. B. Minton, The National Cash Register Co., Dayton, Ohio.

RETENTION *can mean different things...*

...but to a PAPER MILL it means

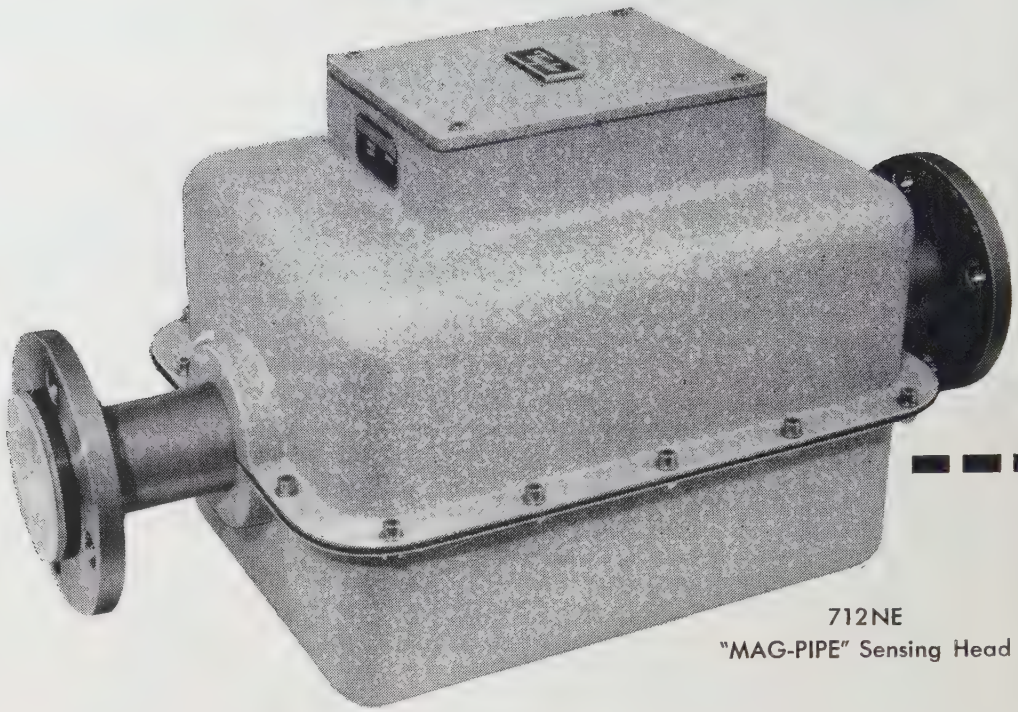
SAVINGS!

***A significant increase in percentage of filler retained*—that's the DOLLAR-SAVING experience of more and more mills as a direct result of using a DARLING glue solution as a wet end additive.**

We'd like to work with you in determining what can be accomplished in your mill. The entire cost is on us, so you've nothing to lose—everything to gain. You can make arrangements through your DARLING sales representative. Or write or call us direct.

DARLING & COMPANY
GLUE DIVISION
4201 South Ashland Avenue • Chicago 9, Illinois

DARLING'S improved BONE GLUE



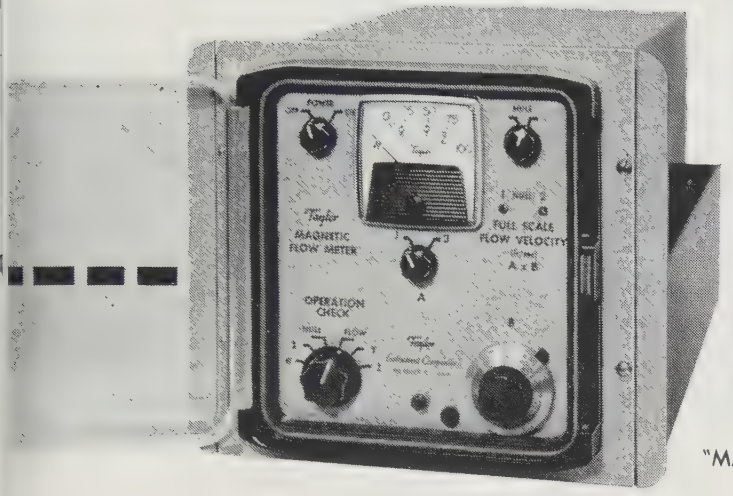
712NE
"MAG-PIPE" Sensing Head

Taylor presents a **MAGNETIC**

OUTSTANDING FEATURES

- High accuracy—½% of full scale on most ranges.
- Full scale velocities as low as ½ ft./sec., at only slightly reduced accuracy.
- Conductivity range—as low as distilled water.
- Rangeability—½ to 30 ft./sec. full scale calibration, continuous vernier adjustment.
- Amplifier—solid state.
- Ideally suited for long transmission runs to a central control panel.
- Output signal—1-5 ma DC into any load from 0-3000 ohms. (Electro-Pneumatic Transducer or TRANSCOPE Electronic Control System).

Taylor Instruments



717TE
"MAG-PIPE" Transmitter

FLOWMETER TRANSMITTER WITH 1/2% ACCURACY

The new Taylor "MAG-PIPE" Magnetic Flowmeter Transmitter is a high quality, high performance transmitter with an output signal of 1-5 ma suitable for transmission over long distances. It can therefore be used with miniature receivers and controllers in central control rooms.

It is designed to measure flow of fluids with an electrical conductivity as low as that of distilled water. It is ideally suited for very low flows, viscous liquids and liquids containing suspended solids, since the flow is not in any way restricted by the primary element.

The "MAG-PIPE" sensing head is mounted in the flow line. It comprises a flow tube, an AC magnetic circuit and two electrodes. The sensing head housing is "hose-down proof" (explosion-proofing optional), and has Van Stone type flanges for easier, faster installation.

The transmitter employs *solid state* components, being fully transistorized for long-term reliability. It is standard in fixed-range form, in which case calibration is factory set at the desired range. Optionally available with a full-scale vernier adjustment on two ranges. A built-in output meter doubles as a circuit checking device.

The "MAG-PIPE" Flowmeter Transmitter is in production. Consult with us on your difficult flow measurement problems. See your Taylor Field Engineer or write for **Bulletin 98418.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Ontario.

MEAN ACCURACY FIRST

practices which we have instituted to neutralize this tendency and to increase the effectiveness of our research organization.

It should be possible for an engineer or scientist to advance to the limits of his capability without having to enter the field of management. But, a considerable problem appears to arise from the feeling of scientists and engineers that they must migrate from the scientific ladder to that of administration in order to achieve maximum status. The use of an incentive system for scientists and engineers which will match that of administrators has been discussed widely in literature as well as in study groups similar to this conference. There are two basic systems from which individual company modifications have arisen: One calls for use of only "administrative" and "scientific" ladders, while the other divides "administrative" into separate "administrative" and "supervisory" ladders. In the former system both "staff" and "supervisory" personnel are included in the "administrative" ladder, while in the latter system they are separate ladders. In order to consider the parameters of parallel incentive techniques, let us examine some of the factors which affect the smooth functioning of such systems.

Engineering organizations and personnel vary with product line, geographic location, executive preference, and employee skill, to name but a few. Any observations on the subject of parallel incentives, therefore, should be interpreted or tempered, in relation to individual company environment. The "care and feeding" of professional personnel is and will continue to be the subject of debate due to the supply and demand situation and the emergence of such expressions as creativity, phasing schedules, sophisticated techniques, and elegant solutions.

The Department of Labor forecasts that the fastest employment growth during the 1955–65 period will take place among professionals. In 1955, this group numbered 5.7 million; by 1965 it should add another 2.1 million—a 37% increase. *Business Week* magazine observes, "The general shortage of brainpower is taking its place alongside death and taxes as one of the basic conditions that management is going to have to deal with for a good many years to come."

In the face of accelerated progress, R & D management must understand the motivation and general perspective of the scientist and engineer. These people consider themselves professionals—and justifiably. They realize the important role they are playing in a competitive society and they expect due recognition.

Let's look at some of the factors involved in the operation of parallel incentive systems and examine them as reasons which motivate a shift from professional to administrative ladders.

Salary disparity
Recognition aspirations
Obsolescence of technical knowledge
Communication shortage
Authority image
Shortage of engineering administrators
Misuse of talent

SALARY

It has often been said that the "true" scientist is not interested in money, but in the advancement of scientific knowledge. This is an excellent attitude for managment to take, since it helps balance the budget—but it loses personnel. A recent Industrial Research Institute study of the most creative individuals showed these individuals to be vitally interested in salary. Small differences in salary are often balanced by challenging research projects—but no sizable salary differences can be tolerated and still retain the peace and productivity of employees.

We must be aware of the impression in the mind of the scientists that the administrator is better paid. This can be a serious problem because management does discriminate between the two groups. Many laboratories try to solve the dilemma by clearly defining the scientific and administrative ladders of salary advancement. Inequality in salary ranges should be explained to the employee wherever possible.

Base salary rates paid to the administrator are often higher than those of the scientist, so it may be necessary to provide additional benefits to the scientist in order to offset this situation. It is essential that scientific salaries be competitive in the field and to the administrative ladder within an organization.

Paying the scientist for patents, publications, and awards is one possibility. Many companies have adopted this practice even though the amount of payments does not equal his administrative counterpart's salary. Corporate support of educational studies and paid memberships in scientific societies have also been a means of scientific reward. A liberal publication policy by management encourages the scientist to place his name before the peers of his profession, and although he may not be able to trade a reprint of his article in *Tappi* for tangible returns, it is adding dollars to his potential earning capacity.

There is another facet of paper publication within industry which needs mention here. Due to competitive activity and patent procedure, it is often necessary for a company to withhold publication of certain breakthroughs until protective steps are taken through its legal and patent departments. This may delay publication for several months or more, but after this period, the scientists credited with the discovery should be allowed to publish his findings.

RECOGNITION

This factor can be subdivided into recognition or stature within the organization and among fellow scientists and recognition among friends, neighbors, and society as a whole. The problem of stature among fellow scientists can best be met directly by industry through establishment of a common set of titles. The young graduate with a new slide rule under his arm is not entitled to the same title recognition as the experienced, proved engineer. Today, the new graduate joins the industrial world as an "engineer," while the proved engineer may be somewhat more glamorously called a "research" or "senior research" engineer. With all of the descriptive adjectives in use, industry has not yet enabled an engineer's counterpart in the field to understand his true level of work.

A generic title system cannot be developed and adopted overnight. However, serious effort on the part of several organizations is now given to evaluation of position titles within industry, and it is hoped that recommendations can be made in the near future. With the diversity of title usage, this task will require cooperation by all industry, but great benefits will be gained by placing a professional man in his appropriate level of accomplishment with a generally understood title.

The other part of the recognition factor—the place of the scientist in the community—requires a title system which will provide a status symbol meaningful to laymen. The physician or attorney has a halo of professionalism. The scientists justifiably wants this also. Today's scientific titles mean little to the average citizen in contrast to administrative titles, such as manager, director, foreman, department head, or vice-president. It could very well be that Mr. Paper Chemist has far more responsibility, higher salary, and is viewed by management as more outstanding than Mr. Director of Services—but to the layman, Mr. Director appears more important to the company. Someone may ask, "What difference does it make as to individual titles, or the neighbor's impression of status in a field?" Although many scientists may agree that it is unimportant, to the majority it is important. In order to attain a recognized title and a "place" in his community, the scientist often decides to "go into management."

ATLAC® 382

GLASS REINFORCED PLASTIC

corrosion resistant construction material for pulp and paper mill equipment

Where corrosion takes too great a toll—in tanks, ducts, fume hoods, chests, vapor condensers (and similar equipment)—you and your fabricator should take a good look at glass reinforced ATLAC 382 bisphenol polyester resin. It offers seven distinct advantages in pulp and paper mill operations as a construction material:

1 Corrosion resistance ATLAC 382 is virtually immune to the bleaches, acids, salts and alkalis used in paper making—at temperatures below 250°F. One example: a 4,400-gallon tank of ATLAC 382 is still in mint condition after two years of alternately storing 14% sodium hypochlorite and caustic soda.

2 High strength Pound for pound, reinforced ATLAC 382 is stronger than steel. You get the same total strength with less total weight. Examples: 30,000-gallon tanks of ATLAC 382 are completely self-supporting...and even the largest hoods need no corrosion-prone metal bracing.

3 Light weight Equipment of ATLAC 382 is generally lighter than wood, Transite, or metal equipment. In one case, a 1,000-gallon tank of ¼" ATLAC 382 weighed 300 pounds, compared with 4.3 times that weight for alloy steel.

4 Economy ATLAC 382 equipment generally costs one-half to one-third less than rubber-lined or tiled equipment, and is normally equal to 304 and lower in price than 316 stainless steel. It is almost always a better buy than the more exotic metals if temperatures and pressures are not too high.

5 Design flexibility There are very few practical limits in size and shape for equipment of ATLAC 382. What's more, equipment can sometimes be redesigned to take advantage of ATLAC 382's unique structural characteristics—resulting in extra simplification, practicality and cost reduction.

6 Easy installation Because of reinforced ATLAC 382's light weight, relatively few men are needed to install it. Also, since it can be joined right on the plant floor, large equipment can be shipped in sections and field-erected. Equipment is readily changed and modified. Ducting can be relocated and reassembled without special equipment or personnel.

7 Low maintenance ATLAC 382 equipment needs virtually no periodic maintenance. It never needs painting or rust removal, always looks clean and attractive. Physical damage is easy to repair generally without down-time.

But why not get the feel of ATLAC 382 for yourself? Let us send you details on ATLAC 382, its uses in the pulp and paper industry, and a comparison of the corrosion resistance of various reinforced plastics. At the same time, we'll be glad to supply a test sample so you can prove to your own satisfaction that ATLAC 382 is well worth considering. For your sample—and data on ATLAC 382—mail the coupon, or write Atlas direct.

Atlas Chemical Industries, Inc
Wilmington 99, Delaware

Please send details on ATLAS 382, and a free test sample.

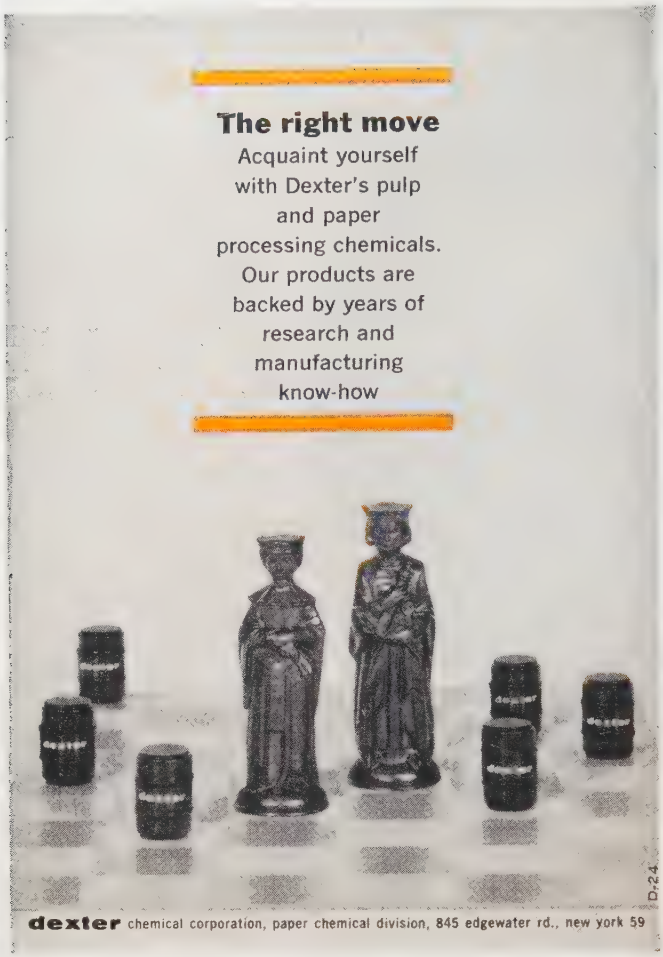
NAME ..... TITLE .....

COMPANY .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

ATLAS CHEMICAL INDUSTRIES, INC.



Dr. Marcson, of Rutgers University, in *Business Week*, after a 1 year study of life in a corporate research laboratory reported some very significant conclusions on this subject. He found that "scientists are hard for industry to handle because their system of "colleague authority" clashes with the corporations system of "executive authority."

By colleague authority the report means the opinions of others in the field. These judgments are often more important to the professional employee than his bosses' opinions are.

Each of us cannot win a Nobel Prize, but each has the desire to "be somebody." It is a responsibility of management to provide the means whereby scientists can "be somebody" in the profession, as well as in society.

OBSOLESCENCE OF TECHNICAL KNOWLEDGE

Today's engineer is joining industry with perhaps the broadest educational preparation in history. This is a credit to universities which are continually striving to match the engineering curriculum with the changing environment of technology. However, this "broadened" engineer still has very little training in basic management principles.

The rapid advance of knowledge often causes the older engineer or scientist to have a feeling of inadequacy, and a sense of falling behind the pace of technical progress. For example, in 1940, *Chemical Abstracts* published 40,000 abstracts from 3000 journals. In 1958, this had risen to 120,000 abstracts from 9000 journals. Further, the sources of knowledge today are no longer predominantly in academic centers, which makes it more difficult to correlate knowledge on advancing fronts.

The factor of obsolescence is also moving engineers toward administrative environment as a matter of "survival." Young engineers, broader in new technology and alive with a desire to remold the technical world, are placing tremendous competitive pressure on the older engineer. Conversely, there is no better preparation for administration than the hard knocks of the first 5 to 8 years of professional engineering.

A point should be made very clear—engineering administration should not be a haven for technical derelicts; good administration requires both a sound engineering background and a talent for dealing with people.

The older engineer often feels that perhaps his best chances for advancement can come in adminstration. Our observation has been that this phenomenon occurs mostly at the average engineer level, rather than with the most brilliant or below average groups.

Many young engineers are too unwilling to serve out a reasonable period of training and experience on a job. As a man grows older in engineering, his most valuable assets are broad and intangible in nature—how to develop good relations with other engineers, and how to assess the significance of a rather indefinite design or experiment. He has built up a sort of mental card index of the laws of engineering and the "state-of-the-art" in one or more specific fields. The point should be made clear, however, that every maturing engineer does not just "fade away" into the Valhalla of administration.

A relatively small segment of older engineers will migrate normally into administration. But what of the great majority of engineers at the bench and in the designing rooms? Our organization is trying a number of approaches, some classical in nature, and some rather unique. Company-paid graduate education is quite popular and quite effective in continuing the engineer's formal training. An aggressive seminar program has been established in which nationally recognized technical leaders are invited to Dayton to address our scientists and participate in group discussions. Attendance at technical meetings and conventions is emphasized within an established budget framework.

We have recently introduced and are circulating a *Technical Information Digest* (published weekly) which covers significant technical and economic factors affecting the data processing field, and of direct significance to our company.

As a part of our performance appraisal system we attempt to determine as soon as possible in which fields an engineer's talents lie, be it in experimental or research engineering, or in development or production prototype fields.

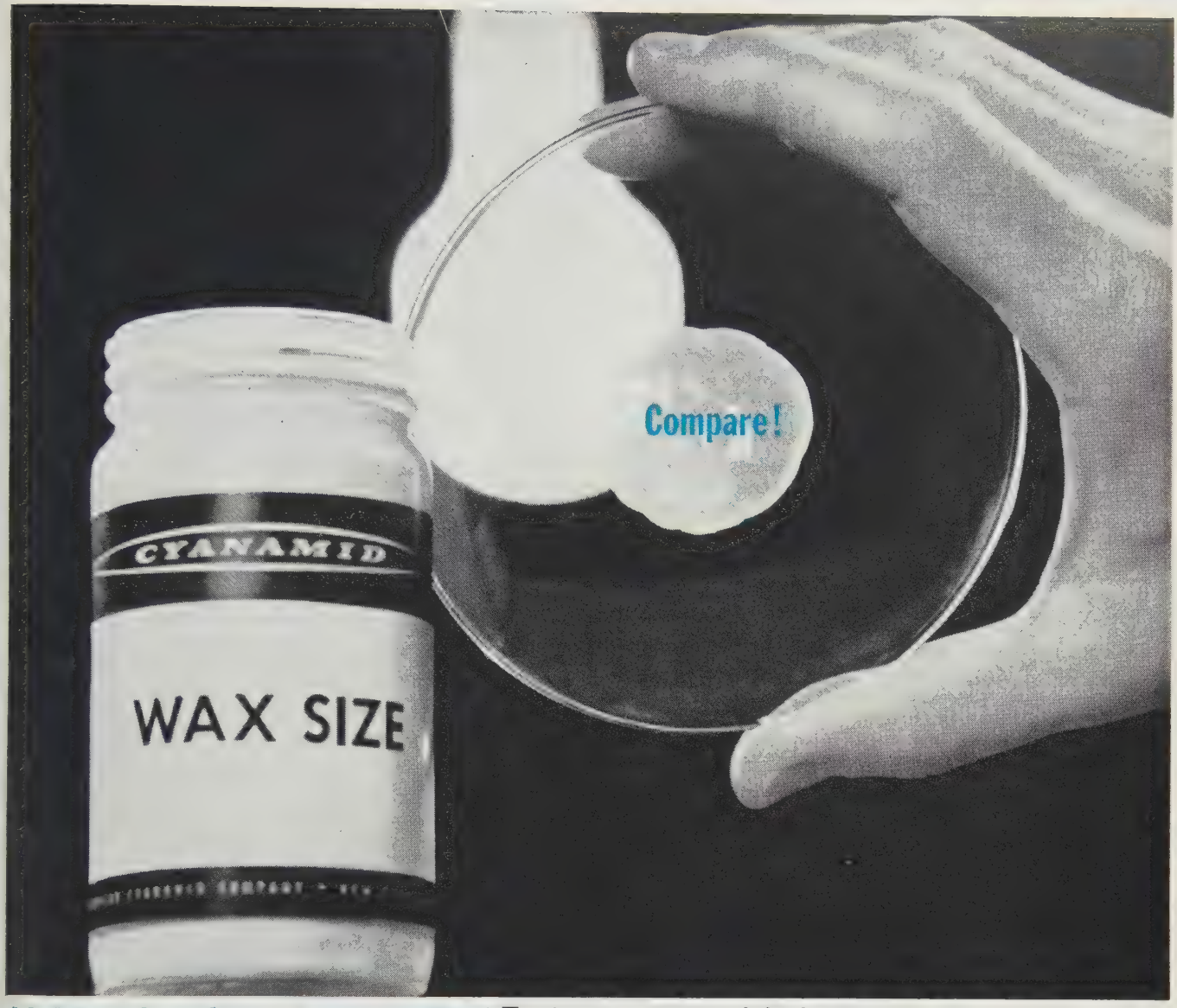
COMMUNICATIONS

One facet of the broad area of communications which has a direct bearing on engineer migration is the need for conveying the "bigger view" to R & D personnel. The technique of communications can serve as a real stimulus to the important factors of motivation, recognition, management attitudes, and effectiveness on the job.

This brings to mind the story of the new West Point graduate who utilized considerable imagination to solve a communications problem. It seems that the young second lieutenant had just been assigned his first platoon when the company chaplain informed him that the mother of one of his men had passed away, and, that the second lieutenant should inform the man of this tragic event as soon as possible. The private was called to the office of the lieutenant who forthwith announced, "Private Smith—your mother just died."

After Pvt. Smith regained consciousness, there was considerable chastisement of the second lieutenant by the chaplain and the C.O. relative to his not-too-subtle communication of the information. Lo and behold, only a week later the chaplain arrived with the news that another of the second lieutenant's men had suffered a tragic loss—"Private Jones' mother has passed away."

The lieutenant pondered the previous event; reviewed the captain's discussion of assignment in the Sahara, and finally



Lightest in color... best stability! Test for yourself the properties of ALWAX* and WAXINE* sizes, the products of Cyanamid, America's oldest—and largest—producers of **Wax Sizes.** See for yourself that they offer the lightest color available anywhere... and the best stability. Other advantages—? Plenty! The most complete line... to assure you of the exact **Wax Size** for your particular need. Compatibility with other paper-making chemicals. Properties that produce paper with lower water absorption, smoother surface, less curl, greater ink resistance, improved lactic-acid resistance. Cyanamid **Wax Sizes** can be used with rosin sizes to increase sizing efficiency, lessen the quantities needed, and create major production savings. Call your Cyanamid salesman for complete technical information to help you select the right **Wax Size** from the widest, lightest line of sizes available today.

*TRADEMARK

CYANAMID

AMERICAN CYANAMID COMPANY • PAPER CHEMICALS DEPARTMENT • 30 Rockefeller Plaza, New York 20, N. Y.

hit upon the perfect communications technique. He assembled his entire platoon and announced, "All men whose mother are living, please step forward—not so fast there Pvt. Jones."

Aaron Levenstein, of the Research Institute of America, has well identified the importance of communications by pointing out that the impact of a company on its employees is in direct proportion to the employees' understanding of the company's philosophy. Industrial R & D must build a relationship between the man and the work he performs as an integral part of the overall objectives of the company.

Not only are the symbols of communication involved (words, either spoken, or written; gimmicks such as company picnics, golf leagues, etc.), but also the messages and the attitudes which are conveyed by such symbols. The professional has a need to know and a right to be informed of such decisions and developments that pertain or affect his work, department, division, and company.

Management is the official pipeline of communication. If the pipeline becomes clogged or rusty through nonuse, the effect will be felt through the attitudes and morale of the staff. In the professional's mind, in order to become a significant link in the communications channel, movement into administration may be considered necessary, since it is the administrative function that serves as the official company communications outlet.

R & D management of our company feels strongly that the tendency to migrate toward the administrative ladder can best be neutralized by a continuing program of development of communications techniques at all management levels.

Let me describe one approach we have used effectively to implement normal communications techniques. For several years, a Communications Committee has been in action, composed completely of professional personnel. The purpose of this committee is to bring to management's attention any problems associated with operating policies and procedures, particularly where such problems may be caused by lack of proper communications or understanding between management and the man. The committee undertakes studies of these problems and presents their recommendations to management for corrective action.

This group has provided a valuable insight to our professionals' attitudes. The committee has enabled us to identify weaknesses in policies and procedures. The result has been a strengthening of rapport between our professional and managerial groups.

AUTHORITY

Another significant factor attracting professionals to the administrative ladder is that of authority. This serves in satisfying an individual's ego and, he believes, insures greater project control. The ego factor of authority is fairly well defined in our minds and was discussed briefly under the factor of recognition. However, the facet of authority which, to the professional man, represents insurance of project autonomy is less understood, but perhaps equally significant. Qualified professionals feel the need for authority to make and carry out decisions. Where this authority does not exist in the technical ladder of an organization, the incentive to move into the administrative echelon becomes strong. To the technical man, the number of people who can say "no" is far greater than those who are best qualified technically to say "yes" and get things moving. Also, those people who say "no" can invariably be found on the administrative ladder. The decisions to initiate programs, to expand the scope and magnitude of program efforts, to implement programs adequately in terms of dollar support, personnel, and facilities is rarely within the authority of scientific personnel. These decisions are generally considered to be management prerogatives and fall within the scope of their responsibilities. For the dedicated scientist whose enthusiasm, talents, and time are almost subjectively linked to the solution of a technically challenging problem, the failure of management to see his work in the same perspective, or to even hint of less than enthusiastic support of his program appears incredible. To protect science and its progress from those who through technical ignorance or misunderstanding could retard or block it, the professional determines to seek the administrative ladder where he can exercise the authority to promote "significant" technical programs. To management personnel, these statements may appear distorted and exaggerated, but to the professional with a limited knowledge of administrative philosophy, such statements are significant. In general, the situation underscores a difference in perspective much like the story of a Chinese delegate to the U.N. who was besieged by reporters when he arrived in New York. One of the questions flung at him was "What strikes you as the oddest think about Americans?" He thought for a moment, then smiled. "I think," he said, "it is the peculiar slant of their eyes."

How can we deal constructively with a motivation of this type which tends to make the administrative function so much more attractive than the professional function? Several procedures have been instituted in our research organization which we believe offset this impression and produce a more healthy perspective. What are some of these techniques?

Communication of the Company R & D Posture

The philosophy of corporate research and development must be effectively presented to each professional so that a complete understanding and appreciation of the R & D function is assured. For the new employee this is incorporated in our orientation program. The subject of R & D philosophy is introduced in the interviewing stage when new applicants are being screened. For the professionals already with us, this philosophy is formally reiterated at periodic R & D objectives meetings presented by the vice-president of research and development to all professional personnel. Informally, this philosophy is practiced on a working basis by program reviews in which programs are examined for progress, status, reaffirmation of objective and re-evaluation of significance. In these meetings, professional personnel hold forth on equivalent terms with their administrative counterparts.

On a more formae basis, we have organized two committees that directly associate our professional personnel with the technical and economic factors of program planning.

Take our Scientific Committee. Typical of other standing committees, our Scientific Committee functions as a communications exchange center. Our Scientific Committee has representation from our Engineering and Planning Divisions to interpret to the rest of our organization significant developments in advancing fields of science, as well as to provide guidance in where research should be directing its efforts to solve R & D problems. Where does our Scientific Committee get its ideas?

Principally, form the man at the bench who *knows* the company's objectives and is alert to general developments in science or can respond with his own innate creativity.

Let me cite an example of how the Scientific Committee functions, both in its manner of attack in evaluating the fields of advancing science pertinent to corporate objectives, and the manner in which decisions may be derived.

There has been well publicized research in the electronics field over the last several years in developing high speed large capacity magnetic memories. Our engineers and scientists have been closely following developments in this field. We have also been conducting a large-scale program to achieve essentially the same type of objective by a significantly different approach.

One of our project engineers recently reviewed before the Scientific Committee the technical state of the art of this work in the field. This review covered the fundamenta

what dramatic
new developments
does the

BELOIT GLOSS CALENDER

bring to
papermaking?

for answer,
please turn page

Beloit GLOSS CALENDER*

brings an improved calendering method to papermaking

While conventional machine calendering is accompanied by reduction in bulk, reduction in sheet strength, and other disadvantageous conditions, the BELOIT GLOSS CALENDER gives promise of producing equal or better finish while preserving bulk and strength.

Many intriguing possibilities are indicated for printing papers, food boards, pretreatment, and final finishing of coated papers, envelopes, and folding boxboards.

In operation, easy handling and improved machine efficiencies should result. The BELOIT GLOSS CALENDER may be used on or off the machine.

*U.S. and Foreign Patents Pending

BELOIT

PAPER MACHINERY

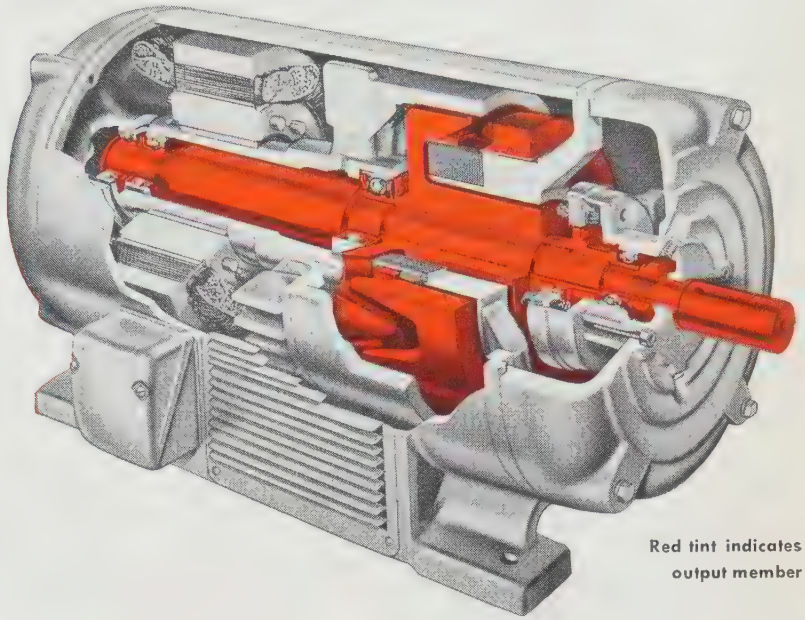
your partner in papermaking

NOW— another FIRST by the Originator of Eddy-Current Equipment

NEW

DYNAMATIC®

Model 905 Ajusto-Spede® Drive



Red tint indicates output member

Extends Capacity Range to 15 HP in the Popular Quill-Type Design

The addition of the new model ACM-905 to the famous ACM-903 and ACM-904 lines of Dynamatic Ajusto-Spede Drives makes the desirable features of Dynamatic Quill-Type design available for many new applications.

Dynamatic Ajusto-Spede Drives provide controlled adjustable speed from an AC power source. Standard control features include on-off clutch control, infinite speed adjustment, constant speed regulation, and jogging. Any of a variety of special features may be easily and economically added to the standard control.

All Quill-Type models are available with either eddy-current, Dyna-torQ, or fail-safe brakes.

An Ajusto-Spede Drive, a control unit (either electron tube or transistorized magnetic amplifier), and a push-button station comprise a compact, easily installed, low-cost drive package.

Check these Ajusto-Spede® Advantages

- ★ Infinitely adjustable speed from AC power
- ★ Simplified construction
- ★ Compact design
- ★ Wide speed range
- ★ Remote control
- ★ Stationary field coils
- ★ Excellent performance characteristics

Send for Illustrated Descriptive Literature

EATON®

EATON DYNAMATIC DIVISION MANUFACTURING COMPANY

3122 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

PAPER IS MORE USEFUL...THANKS TO COLUMBIA-SOUTHERN CHEMICALS

Paper plays an increasingly important role in our daily activities. We use it in packaging . . . in cigarettes . . . in building . . . in photography . . . in decorating . . . plus the traditional uses as a writing and printing material. In prospect for the future . . . paper clothing! ¶ The greater versatility of this ancient commodity is due, in large part, to advances made by the chemical industry. New developments in pulp and paper processing utilize such basic Columbia-Southern Chemicals as chlorine, caustic soda, hydrogen peroxide, soda ash and silica pigments. Many other industries use Columbia-Southern Chemicals . . . from PPG. Perhaps there's a place for Columbia-Southern Chemicals in *your* business.

columbia | southern chemicals
CHEMICAL DIVISION
PITTSBURGH PLATE GLASS COMPANY
ONE GATEWAY CENTER PITTSBURGH 22, PENNSYLVANIA
DISTRICT OFFICES: Boston · Charlotte · Chicago · Cincinnati · Cleveland
Dallas · Houston · Minneapolis · New Orleans · New York · Philadelphia
Pittsburgh · San Francisco · St. Louis · IN CANADA: Standard Chemical Limited

materials problems facing successful application to memories; an analysis of the circuit problems associated with this concept; and an evaluation of the advantages and disadvantages of the approach followed in the field to those being followed by our R & D organization. The summary and conclusions presented by our project engineer were based on economic considerations associated with our short and long range product needs as well as the technical feasibility of the two approaches under consideration.

The review cited is significant in that from the bench level in two of our Engineering Divisions and from another segment of our Research Division immediately were raised questions on the overall conclusions of the report. The Scientific Committee in its role of communications exchange center served to effectively arbitrate the variance of professional opinions aroused by this technical review.

Let me stress—the flow of information in this example of scientific review is from the engineer level upward. The review is a representation of technical and economic judgments. The data, conclusions, and recommendations are made known to our R & D complex, with an opportunity for counter points of view to be presented and defended. The role of the Scientific Committee is tremendously enhanced in arriving at a decision by the opportunity to hear qualified judgments from all segments of our R & D group who have a vital interest in the technology under examination. Decisions made under this method of approach will be on the basis of best technical judgments from the people best qualified to judge, i.e., the project engineers and scientists. Judgments combine the important factor of economic awareness of corporate goals with an evaluation of technical feasibility, and represent decisions evolving from the bottom up rather than impressed from the top down.

I should like to refer to another technique we have used in the education and participation of our scientific personnel in basic research planning. This technique is that of planning and organization of research programs. The basis of this system is a Research Planning Board, composed of scientific and supervisory personnel, and a document which we term a P.I.R. (Project Initiation Request). P.I.R. forms, as you see here cover all research projects active in our Research Division today. Let me digress a minute and discuss this in more detail. P.I.R. forms originate largely on the project engineer or senior scientists level. These forms define the program objective; the significance of the program to corporate needs; and provide in detail the technical phasing, manpower assignments, supporting costs, and relationship of the program to established budgets. Back-up information always accompanies a P.I.R. form to detail, where applicable, market estimates and returns, or the relationship of the project in terms of contributed value to the product line. The point I wish to make here, is that an economic analysis originates as an essential part of the technical planning document, on the level of the project engineer or senior scientist and a decision is made on the basis of the greatest return in terms of needed technology for the money, time and personnel investments required.

Since I have given considerable import to economic analysis, it might be well to read a description of economic analysis with which some poetic license has been taken.

I multiply your projects by the words I can't pronounce,
And weigh your published papers to the nearest half an ounce;
I add a healthy bonus for research that's really pure
(And if it's also useful, your job will be secure.)

I integrate your patent-rate upon a monthly basis
And I figure what your place in the race to conquer space is;
Your scientific stature I weigh upon some scales
Whose final calibration is the company's net-to-sales.

And so I create numbers where there were none before;
And thus have facts and figures and formulae galore—
And these volumes of statistics make the whole thing very clear;
Our research should cost exactly what we've budgeted this year!

No offense is intended to any comptroller's who may be present.

A P.I.R. may be initiated at the scientists level, with the standards of economic and technical evaluation applied as indicated. Screening of P.I.R.'s follow their initiation, so that an ever-broadening scope of knowledge on corporate needs may be brought to bear in their evaluation. Progressively, a P.I.R. is reviewed by the department management in the area where P.I.R.'s originate; and finally is reviewed by the Planning Board, composed of top technical and administrative personnel. The Planning Board evaluates all programs on the basis of relative significance to company needs and in relation to available resources, personnel, and time maturity. Programs thus receive a final sort with the most important receiving emphasis and allocation of available resources.

In brief, technical creativity combined with an awareness of economic factors originates at the scientist level, is progressively screened through management, and initated for action by Planning Board review. The indoctrination of economic

The advertisement on the opposite page appeared recently in *Business Week* and *Wall Street Journal*—a total circulation of over 1 million copies to business and financial leaders, who can be helpful to both your business and ours. ¶The Paper and Pulp laboratories of PPG Chemical Division have some new results from their work on low-cost Silica Pigments which they'd like to discuss with you. Why not get in touch with us soon? Chemical Division, Pittsburgh Plate Glass Company.

PAPER IS MORE USEFUL ...and it's featured in BUSINESS WEEK

factors with technical creativity on the scientist level insures a smaller percentage of misdirected technology; management and Planning Board reviews provided added breadth and depth of economic technical evaluation.

Review periods for every technical project or program are established in the original planning document in terms of technical and economic mileposts. Formal reviews of programs are held at these periods by the Planning Board, with a thorough analysis of technical progress and a revalidation of technical objectives in terms of contribution to a product need. Informally, periodic reviews of all programs within a section are held by research management in which these same factors are considred. On a daily basis, each engineer and scientist consciously or subconsciously exerts technical judgment *tempered* by the economic factors related to his project.

As in the project initiation phase, reviews of project status are held in depth, with each level of review bringing to bear a broader knowledge of technical and economic judgments.

Again, by this exercise of combined technical-economic evaluation, emanating from the bottom up, the risk of misdirected, poorly conceived, nonproductive, product research is continually reduced. The scientist has been the key element in the planning and control phases of all projects, and is made to feel vital in all decisions relating to the status of his program.

SHORTAGE OF ENGINEERING ADMINISTRATORS

Several factors have been discussed which are self-motivating wherein the engineer himself desires to move from the professional ladder to the administrative role. But another factor tends to bring the engineer into administrative environment at a complete disregard of his own desires—the shortage of engineering administrators.

Three well-known factors contribute to this shortage:

1. The rapid advance of technology is requiring an increasing number of technically competent administrators in research and development programs. Not many years ago, a specific engineering product or piece of hardware may have required two or three engineering administrators. In today's "black box" era, a similar product may require many more administrators with an even greater expansion of engineering manpower. An interesting example of this trend is the 3,464,000 engineering man-hours required for the first B-47 bomber as compared to the 85,000 engineering hours required by the first B-17 bomber.*

2 The very nature of industrial dependence upon mass production and technology along with the engineer's competence in directing these efforts is creating a demand for engineers is nontechnical and semitechnical fields.

3 The supply of engineers from which expanding technology and other fields can draw administrative talent is decreasing in the face of market demand. One easily foresees a continued high demand for engineers in the face of expanding technology, decreasing high school population, decreasing interest in science on the high school level, and decreasing enrollment in engineering colleges. We are not prepared to offer a panacea for this situation; however, industry and the academic world have been challenged by thier own ingenuity to maintain the pace of progress.

What can we do to alleviate the situation? Both industry and the universities must face up to a joint responsibility for increasing the engineering population the next 10 to 20 years. There have been numerous proposals relative to stimulating interest through scholarships, research grants, part-time teacher work in industry, popularizing science and its rewards, etc. Most are worthy ideas and many are being carried out with varying degrees of enthusiasm.

Our efforts in the past have been piece-meal. In order to solve this problem quickly and effectively, industrial and academic leaders must actively support by public declaration, with personnel, and with dollars, a program coordinated by some central agency.

MISUSE OF TALENT

One final factor causing migration to administrative ranks we believe to be the misuse of talent. The assignment of a electrical engineer to soldering transistor connections in a prototype is an obvious misapplication of talent. Amusing as may be this is illustrative of many current uses of engineers.

A group of individuals who have been assigned tasks below their technical level can well develop a desire to become "administrators" or resign. The creative individual performing a menial task reasons his plight in this manner; first, he believes that management does not understand and appreciate his capabilities, and he is resentful of management action. Secondly, salary rates are established on the value of the job to the company. By performing a job below his level of talents, the engineer may be paid less than his capability warrants. The result—a morale problem leading to reduced effectiveness, resignation, or a desire to transfer to administration.

We, at the N.C.R., try to maintain effective manpower utilization. We make an effort to avoid:

1. Too many assignments which could have been adequately handled by lower level professional personnel (synonomous with lack of challenge and failure to utilize a man's specialized training and background).

2. Lack of opportunity to work on research ideas of the scientist's choice (synonomous with inhibited initiative and creativity).

We are extremely careful in the placement of individuals with respect to their educational and experience background, the physical and professional environment of the job, and the periodic re-evaluation of these factors in relation to position requirements.

We are also providing, and encouraging each qualified scientist to use up to 15% of his time in the research of ideas of his own choosing. We only require that such research of own choosing. We only require that such research be within the broad corporate objectives of the company. It is felt that this will provide an opportunity to exercise his full talents, and a challenge in the position to which he is assigned.

CONCLUSION

I have attempted to show that we need to bring about a better understanding of corporate philosophy, a greater significance to the position of the scientist and engineer, and an opportunity for him to advance up the scale in his own area of interest by an incremental salary pattern on a par with management.

In answer to the common need to retain scientists and engineers on the professional ladder, those who manage research and development organizations must be aware of several significant reasons why the professional desires to shift to administration.

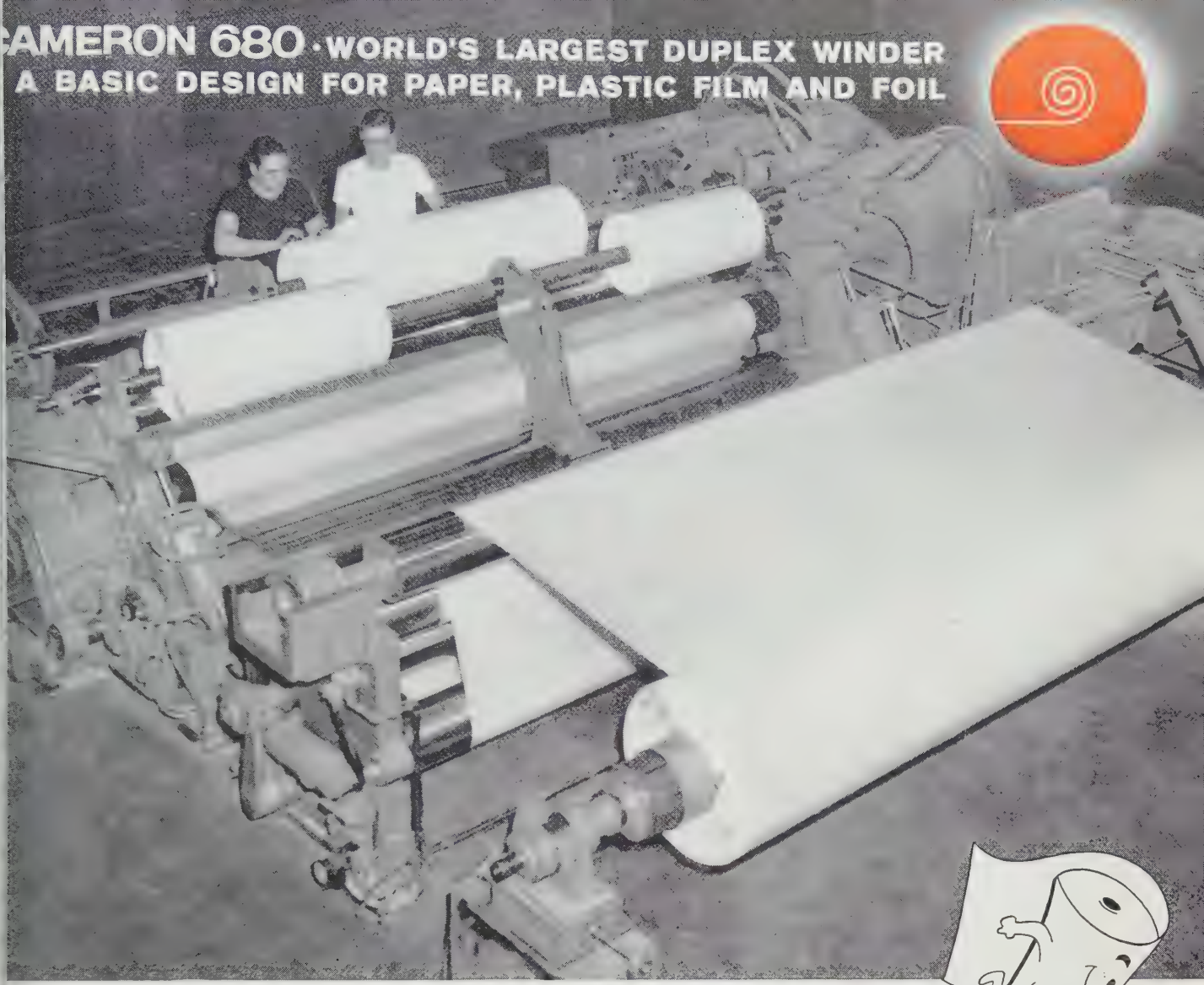
1. A belief that the *salary* range available to the administrator is unattainable on the parallel professional ladder. Where this is true, steps should be taken to implement the base salary with other rewards, such as payment for patents and publications, and support of continued formal education.

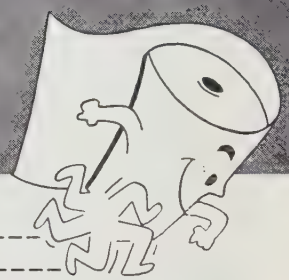
2. A suitable *recognition* system is not available in the welter of job titles that exist throughout industrial technology. Confusion and lack of uniformity in professional title structures provide an inadequate basis for effective use of titles as status symbols. A "common language" of titles and corresponding job descriptions is badly needed in the community of industrial scientists and engineers.

3. The *obsolescence* of technical knowledge, created almost on a daily basis by today's professional, may prompt him to seek a management responsibility which does not demand

* Charles E. Wilson (former Defense Mobilizer) in 1951 fourth quarterly report to the President.

CAMERON 680 · WORLD'S LARGEST DUPLEX WINDER
A BASIC DESIGN FOR PAPER, PLASTIC FILM AND FOIL





Nicolet Paper Corp. *delivers* *the superb running qualities of* The New Roll

(IN LARGER DIAMETERS THAN EVER BEFORE)

operation at the Nicolet mill (West De Pere, Wis.) for more than a year, the 680 has proved itself on glassines, greaseproofs and supercalendered sulphites over a range from 25 lb. to 70 lb. basis weight. The 680 has delivered 36″ diameter rolls of superb *running* quality, holding more than 13¾ miles of paper, with plenty of capacity still in reserve to meet future needs (50″ rewind diameter, 2000 fpm winding speed).

The new, large diameter roll stands up well in handling, storage and shipping. Trouble-free feeding through a long dependable run minimizes downtime due to web breaks and roll changes. It keeps the paper *fresh* and *alive* for better end results. That's why we call it The New Roll!

Like other smaller Cameron duplex systems the big 680 uses combination surface-and-center winding, applying the differential principle to allow each roll to set its own winding speed, thus compensating automatically for variations in caliper.

A variable speed hydraulic main drive, with individual speed control on each of the hydraulic rewind drives, separates control of winding speed and roll density on each set of rewinding rolls. Adjustable, pneumatically actuated, tapered automatic counterbalancing controls nip pressure separately on each set of rolls.

Among other 680 features contributing to roll quality are: the Cameron F-2 unwind and continuous duty brake; the Cameron 950 dancer roll tension system; and the hydraulic-pneumatic edge guide. All control elements are integrated, and adjustable to characteristics of the material, quality of the parent rolls, and intended use of the finished rolls.

See *before you buy*. Test-run your material on a job-fitted "pilot" system at the Cameron research and development service in Dover, New Jersey. Write today for complete information.

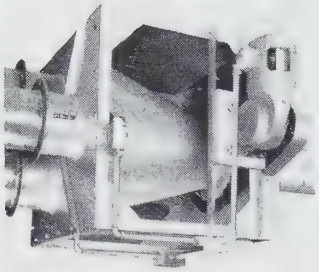
CAMERON

A TEAM OF SPECIALISTS

AA-397

Cameron Machine Company, Franklin Road, Dover, N. J.
Canada: Cameron Machine Co. of Canada, Ltd., 14 Strachan Ave., Toronto, Ont.
France: Cameron Europe S/A, 5 Rue de Prony, Paris (17e) France
Brazil: Cameron Maquinas Ltda., Rua 24 de Maio, 104-5°, Sao Paulo, Brasil
famous TIDLAND pneumatic shafts are sold exclusively through Cameron

... more ideas for profit with OBP MODERN TRIM HANDLING SYSTEMS



Compact "Selektor" valves automatically separate grades! Get higher scrap prices!

Floor pick up stations installed as integral part of system. Get MORE for the same money!

Crusher-shredders accept broke for direct feeding into pneumatic system! Reduce handling costs!

Call an OBP engineer for your requirements survey. You may be surprised at the money you can save!

OHIO BLOW PIPE CO.

1728 Doan Avenue
Cleveland 12, Ohio

. . . leader in design, manufacture, and installation of pneumatic handling and dust control systems.

such rigorous technical detail. A partial answer may be found in company support of continued education, attendance at technical seminars and conferences, and publication privilege.

4. Inadequate *communication* from the top down leaves the professional with inadequate knowledge of company position, direction, and policy. He reasons that administrative work will provide a glimpse of the "big picture," enabling him to better coordinate his thinking with company objectives, and simultaneously provide the satisfaction that comes from "being in the know." Proper communication channels will often remove this source of pressure for ladder change.

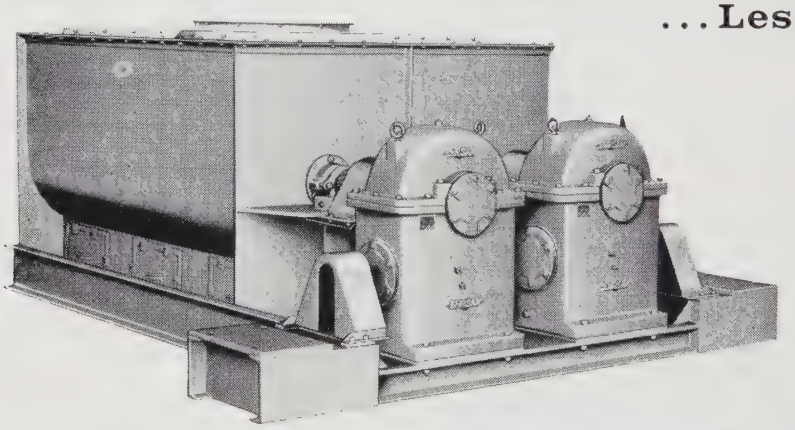
5. Supervisory responsibility implies an *authority*, not available to the professional, which handles matters of program implementation through manpower and budget. Thus the professional, sincere in wishing to enhance his productivity, will seek a supervisory position, thinking that dollars, manpower, and facilities can be obtained more readily.

6. *Misuse of Talents* creates an understandable dissatisfaction in the professional man. To him the alternative solutions may be resignation, transfer, or a shift to administration. However, diligent and continuous effort on the part of management to appraise the scientist's capability in relation to work assignment and project objectives will avert the problem for the man and contribute significantly to program realization.

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

EHRSAM® DOUBLE-BARREL MIXER

Increases Productivity ...Lessens Costly Downtime



The Ehrsam double-barrel paddle mixer writes its own ticket for economy and increased productivity as a fast, heavy-duty machine for the intensive blending of dry, powdered or granular materials.

Precision engineering and construction cut costly, annoying downtime. Steel plate mixing barrels, adjustable stuffing box seals, heavy-duty roller bearing pillow blocks are only a few of the stress points designed to withstand abusive, day-after-day operation.

Combined with a surge hopper, charging hopper with scales, Ehrsam will program an automatic charging, mixing, and discharge operation to your specifications.

20 TO 120 CUBIC-FOOT MODELS AVAILABLE

The J. B. EHRSAM & SONS MFG. COMPANY

Enterprise, Kansas

DISTRICT OFFICES

Kansas City, Kans. / Denver, Colo. / Chicago, Ill. / San Francisco, Calif. Fort Worth Tex. / Phoenix, Ariz. / Hastings, Neb. / Albuquerque, N. M.

EHRSAM® **Enterprise, Kansas**

Please send new Ehrsam Mixer Catalog 8A. I am also interested in surge hoppers___; screw conveyors___; Dracon___; belt conveyors___; and bucket elevators___.

NAME_____

FIRM_____

ADDRESS_____

TOWN_____ STATE_____

E-M/2-661

improved enzyme converting starch

PEARL PLUS is a new specially treated pearl starch that is particularly designed to stabilize and fully utilize the amylose molecular fraction of cornstarch. A more stable viscosity is obtained and flow properties, filming characteristics and binding strength of the converted starch are improved. For a given viscosity a starch of less molecular degradation can be applied to paper without operational limitations.

PEARL PLUS requires appreciably less enzyme to convert to a given viscosity than regular enzyme converting starches. Converts at higher solids. Converts more rapidly, often eliminating temperature holding cycle. Standardizes quality with more consistently uniform final viscosities after conversion.

PEARL PLUS is an important new development in improving cost-quality relationships. It has been thoroughly proved in extended mill runs. We'd be pleased to discuss its advantages with you more fully.

National STARCHES

NATIONAL STARCH and CHEMICAL CORPORATION

750 Third Avenue, New York 17 • 87 Haynes Street, N.W., Atlanta • 3641 So. Washtenaw Avenue, Chicago 32 • 735 Battery Street, San Francisco 11
And All Principal Cities in the United States, Canada, England and Mexico

Here lies the profit

This stock was supposed to become paper. But it got lost along the way.

There it lies, rotting away, wasting valuable chest space and cutting down productivity. Worse, it's a constant threat to the mill's quality control.

Worst of all, it shows that this storage chest is lazy—not doing the work a chest ought to do. Without good agitation, stock is coming in and channeling right through to the pump suction. There's no control over short-cycle swings in stock consistency — without using another chest or throwing an excessive load on the controllers.

Could any of these things be happening in your stock chests? Your LIGHTNIN representative can show you how to resurrect that lost productivity fast—with engineered agitation that makes chests work harder, do exactly what you want them to do.

He can help you get complete uniformity in a chest—consistency that varies *less than 0.1%* (bone dry). He can help you eliminate stratification and stagnant stock. He can provide LIGHTNIN Paper Stock Agitators that give you fully predictable stock-chest performance. And he can do it on a results-guaranteed basis.

Get in touch with him soon. He's listed in Thomas' Register and in the yellow pages of your telephone directory. Or write us for complete information.

CONSISTENCY of stock coming from this chest is completely predictable. Stock consistency in bottom zone equipped with LIGHTNIN Paper Stock Agitator varies less than 0.1%. Stock can't stagnate anywhere in chest.

Lightnin® Mixers

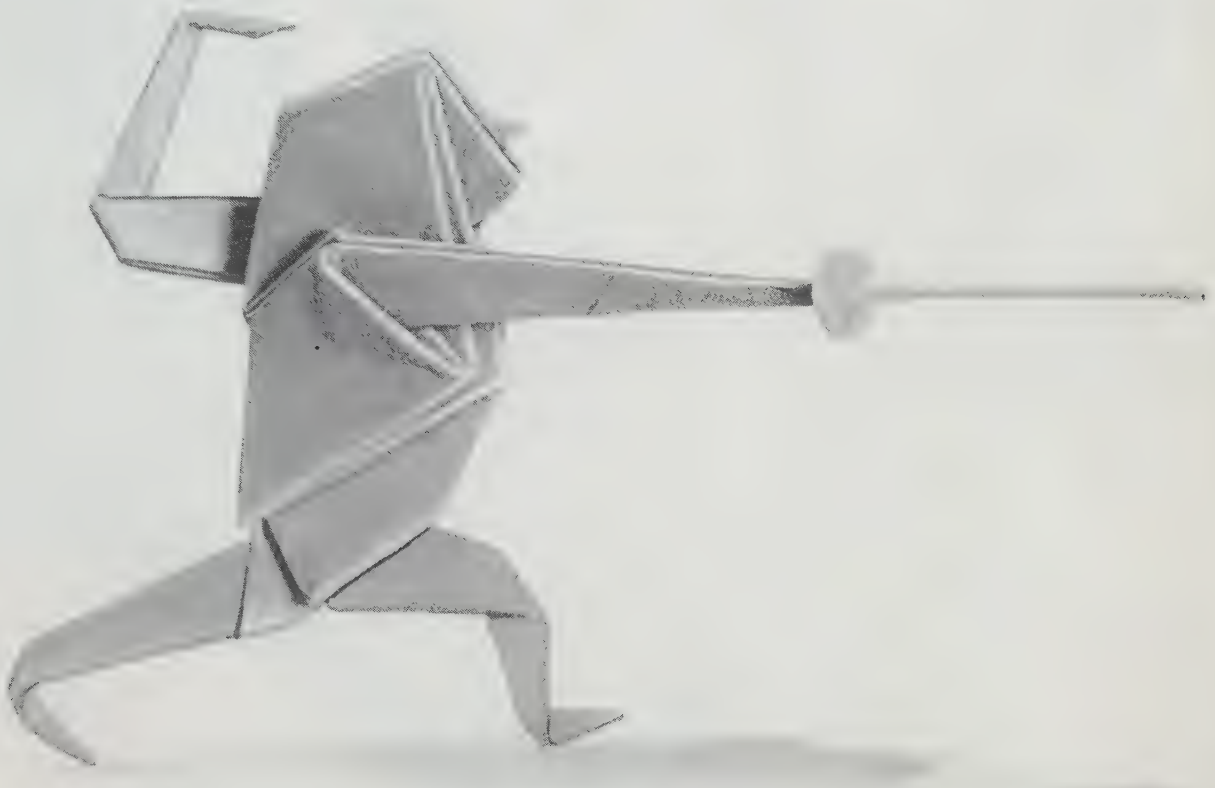
MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc., 142-¡ Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

In Europe: Lightnin Mixers, Ltd., Poynton, Cheshire, England

Paper sculpture by Giuseppe Baggi



Pulp from Gottesman means...

PERFORMANCE!

Bleached and Unbleached Sulphite • Bleached Hardwood • Groundwood
Bleached, Semi-Bleached, and Unbleached Kraft

GOTTESMAN–CENTRAL NATIONAL

ORGANIZATION

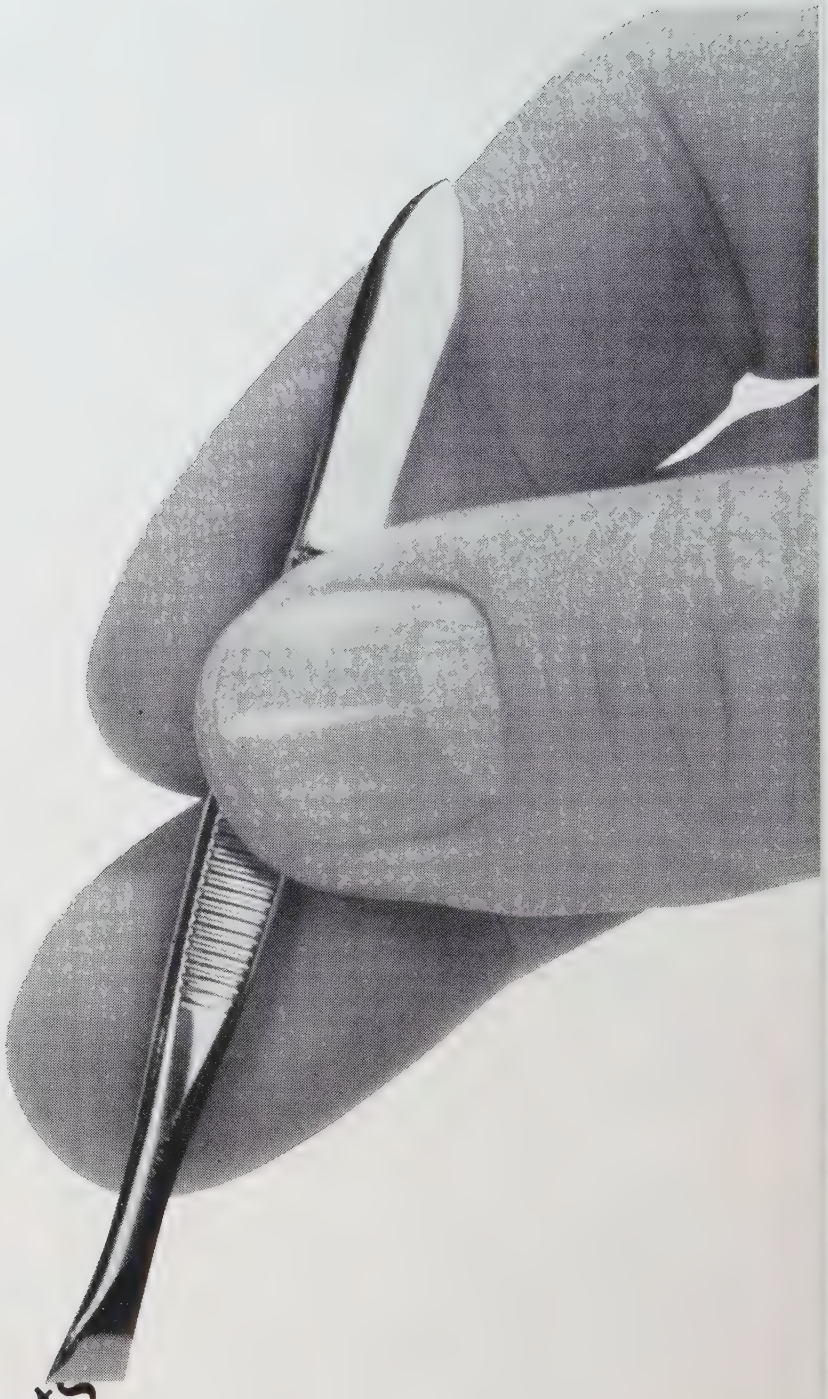
WOOD PULP

PULP PAPER EXPORT CNC

Established 1886

Gottesman & Company, Inc. • Central National Corporation
Central National Commercial Company, Inc.
100 Park Avenue, New York 17, N. Y.

Gottesman & Company Aktiebolag, Stockholm, Sweden • Central National-Gottesman Limited, London, England • Representatives in 55 Leading World Markets



Mathieson takes costs out of caustic deliveries

A major cause of high shipping costs is the distance between your plant and your supplier. When your caustic soda is marked Mathieson, you can count on fast, economical delivery from one of eight producing plants and shipping points (with a ninth under construction) covering the industrial East.

Other ways Mathieson lowers delivery costs? Only Mathieson ships 73% caustic by truck for fewer trips, less weight on shorter hauls. Only Mathieson schedules truck shipments so you get caustic when you need it.

And, of course, Mathieson service backs every order with technical assistance—on the spot or in our laboratories. Call or write OLIN MATHIESON, Baltimore 3, Md.

Ammonia • Carbon Dioxide • Caustic Soda • Chlorine • Hydrazine and Derivatives • Hypochlorite Products • Methanol • Muriatic Acid • Nitric Acid • Soda Ash • Sodium Bicarbonate• Sodium Chlorate • Sodium Chlorite Products • Sodium Methylate • Sodium Nitrate • Sulfur (Processed) • Sulfuric Acid • Urea

8957

CHEMICALS DIVISION Olin

The secret that couldn't be kept!

When the Johnson Rotary Syphon was ready to go, it was our intention to keep it under wraps for a while . . . until it had been thoroughly field-tested; until we had licked all installation problems; until we had a reasonable inventory on hand.

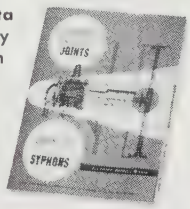
But good news has a way of getting around, and the clamor for test installations began almost before the patterns were finished. Today Johnson Rotary Syphons are operating in more than 50 mills. Many of these have already embarked on programs of complete conversion.

It is no longer a secret that the Johnson Rotary Syphon represents an important breakthrough in draining condensate from dryer rolls of paper machines. A new concept of pick-up design holds condensate film to a minimum, for optimum transfer of heat units to dryer shell. Better drainage helps reduce horsepower demand; eases bearing wear caused by prolonged "cascading"; cuts maintenance all along the line.

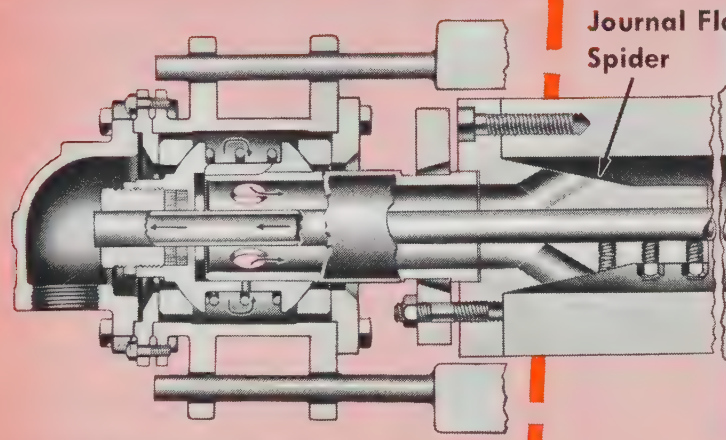
Ease of installation is a welcome feature. The Johnson Rotary Syphon can be inserted right through the manhole; there's no need to get inside, no internal drilling or tapping. There's even a journal-inserted syphon for dryers with handholes only. The Rotary Syphon can be installed anywhere along the face of the dryer shell.

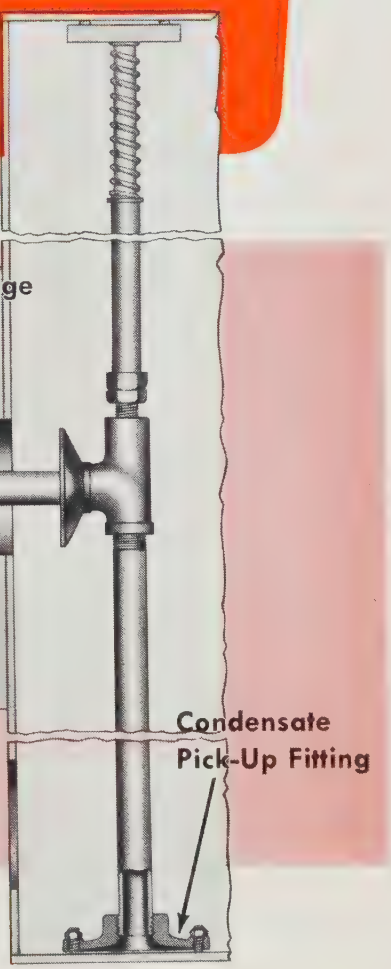
As a logical sequel to the Johnson Rotary Pressure Joint, this new Rotary Syphon completes the task of getting steam in and condensate out of dryer rolls and squeezing maximum effect out of the heat units contained. One secret remains for you to discover: just how much it can improve production and cut costs in your mill!

For engineering data — with the full story of research, design and construction ask for copy of "Condensate Behavior in Paper Machines"



The New JOHNSON ROTARY SYPHON





SUPER TYPE L-N JOHNSON JOINT
with "Quick Release" Nipple

Best Design yet for use with rotating syphon pipe • ***Super Construction*** and stamina • ***Floating Action*** . . . side-steps life-shortening dead weight • ***Easy on, and off*** . . . with just a crescent wrench.

THE JOHNSON CORPORATION

843 Wood Street, Three Rivers, Michigan

Rotary Pressure Joints • Direct Operated Solenoid Valves

Nopcote® C-104 is out of this world when it comes to lubricating protein, starch or latex coating colors. A fluid-stable, 50% calcium stearate dispersion, it produces a clean, dust-free coating with improved gloss—even at low calender pressures.

This lubricant improves flow and leveling characteristics to the point where a smooth, even application is possible at high speeds and on any equipment—trailing blade, roll train, air knife, or size press. It minimizes surface pattern, too, and gives your sheet an increment of salability.

This mill-proven coating additive is fluid and easy to handle. Other advantages are that it has little effect on color viscosity and permits application of high-solids, quick-drying coatings.

Nopco technical representatives will be happy to supply samples of Nopcote C-104 and set up a mill trial at your convenience.

Dispersants
Defoamers
Wax Sizes
Calender Stack Lubricants
Detergents
Emulsifiers

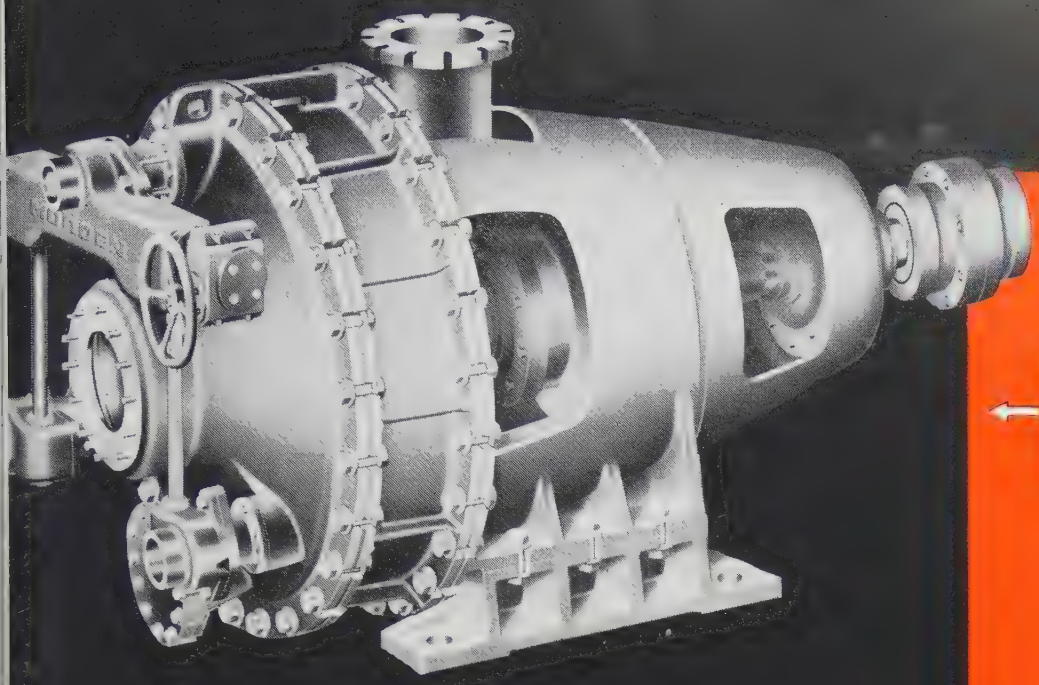
NOPCO CHEMICAL COMPANY

NOPCO®

60 Park Place, Newark, N.J.

Plants: Harrison, N.J. • Carlstadt, N.J. • Richmond, Calif. Cedartown, Ga. • London, Canada • Mexico, D.F. • Corbeil, France • Sydney, Australia

Manufacturing Licensees Throughout the World



the precise self-aligning MORDEN DISCO-FINER

one versatile machine that provides: amazing precision • tremendous productive capacity • self-pumping, self-pressurizing • low power per ton of production • easily adapted to defiber or refine

Here is a truly significant development in stock preparation equipment. Simple flow and filling changes adapt the new DISCO-FINER so that it will either defiber or refine. The self-aligning, semi-conical design of rotor and stator plates eliminates warpage and distortion. The DISCO-FINER is designed to deliver high production without sacrifice of quality, designed to withstand many times the stresses of normal use so that precision is maintained under all conditions.

HOW THE REVOLUTIONARY MORDEN SELF-ALIGNING SYSTEM ASSURES PRECISION

In conventional flat disc design, it is difficult to maintain alignment because of shaft deflection and bearing clearances. Morden's creative engineering has overcome this disadvantage through semi-conical plate design. The Morden design assures that plates are maintained in perfect relationship to one another.

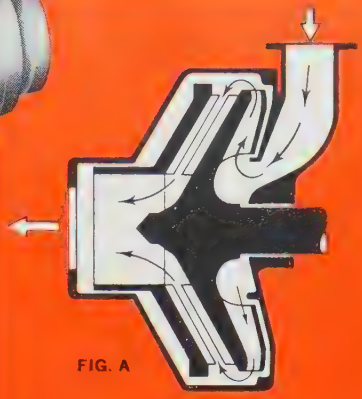


FIG. A

REVERSE FLOW
SELF-PRESSURIZING
FOR REFINING

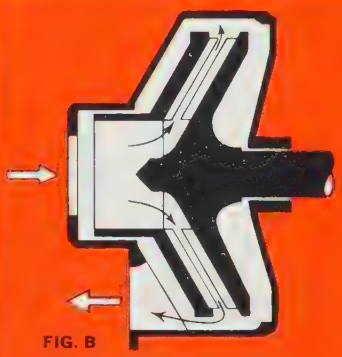


FIG. B

FREE DISCHARGE
FOR DEFIBERING

COMPARE THESE FEATURES WITH THOSE OF ANY OTHER DISC REFINER

1. High production with precision treatment.
2. Low power per ton of production.
3. 500 to 700 connected horsepower.
4. Easily adapted for defibering or refining.
   a. Reverse flow, self-pressurizing for refining. (See Fig. A above)
   b. Free discharge for defibering. (See Fig. B above)
5. Variety of plate designs and materials.
6. Precise plate adjustment.
7. Standard bearings and coupling.
8. Low maintenance.

Before you order another machine for stock preparation, see all the data on DISCO-FINER. Write for detailed information.

MORDEN
MACHINES COMPANY
3420 S. W. MACADAM AVENUE • PORTLAND 1, OREGON

TELEPHONE: CAPITOL 2-9355 • CABLE: "MORDEN"

Mordenize . . .

Send for information on Morden's complete line of pulpers, refiners and jordans . . . the standard of high quality in the industry.

A good line to remember

Mark this down with your lines of truth: "Coated stock with a uniform finish makes sales go up." CLINTON starches and dextrins make sure your coating is consistently smooth and free from "skips." When gloss printing quality and strength count most, use CLINEO starches. And, to improve all-around printability and control curl, specify CLINCAL starches (they contain their own lubricants). With these starches, you can select from many varieties. Customers and prospects who judge paper on its face value can see and feel the difference when you use CLINTON coating starches.

Technical service always available

CLINTON CORN PROCESSING COMPANY

CLINTON, IOWA

60

paper machines

are now using

AQUAPEL®

sizing agent on a

regular basis

Plant capacity

is now tripled

to meet the

growing demand for

AQUAPEL

HERCULES POWDER COMPANY

INCORPORATED

PP61-7

Pine & Paper Chemicals Department

Hercules Tower, 910 Market Street, Wilmington 99, Delaware

A MEASURE OF PERFORMANCE. After two years' service during which power requirements varied between 600 and 1000 hp, these nickel stainless steel discs show wear averaging only .0027" per month, evenly distributed and with parallelism retained. *Photo courtesy E. D. Jones Corp., Pittsfield, Mass.*

Resist corrosion and erosion

Nickel stainless steel discs figure to last more than 23 years

Take note of this date: September 7, 1957.

That was the day a nationally known paper company began board production, using 10 Jones Double-D refiners for primary and secondary refining of highly corrosive pulp. Each refiner is equipped with nickel stainless steel discs through which the pulp is refined.

Two full years passed. Late in 1959, inspection of the all-important discs indicated that all were in excellent shape. Wear? Only .065" — all evenly distributed, and with parallelism perfectly retained.

Regular six-month inspections show a maximum wear of only .0027" per month on the stainless discs. Applied against the available disc wear of .750", this figure actually indicates a *disc life of more than 23 years.*

It's easy to see why. Nickel stainless steels combine exceptionally high resistance to corrosion and erosion with at least four other important characteristics:

- **High strength**
- **Stiffness**
- **Good machinability**
- **Long wearing qualities**

That's why nickel stainless steels are finding such widespread use in mills today. Cast—or machined from plate—the pulp and paper industry has proved them dependable on jobs where many metals simply don't work out.

Have you a problem that a nickel stainless steel casting might solve? You may find the solution in our new free booklet, *Heat Resistant Castings, Corrosion Resistant Castings, Their Engineering Properties & Applications.* Sent without obligation. Just write for "Booklet A-266."

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street INCO New York 5, N.Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

FINISHED PRODUCT PROCESSING EQUIPMENT Winders • Reclaim Winders • Cutters • Sheeters • Slitters • Supercalenders • Roll Wrappers • Roll Lowering Tables • Roll and Shaft Handling Equipment • Conveyors • Unwind Stands and Tru-Tension Controls • and other equipment for the paper and allied industries.

before you decide on a new **unwind stand**

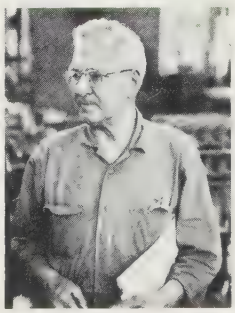
meet some "Beloit Eastern" people

OSCILLATING UNWIND STAND on the erecting floor is checked out by chief inspector Earl Reese, head of quality control, and field erector Jack LeFevre. Precision requirements and highest performance standards are rigorously maintained.

PHOTOS: J. R. CHRISTENSEN

REESE brings 20 years' experience to quality control.

LEFEVRE, veteran of 37 years, is widely known.



Member Beloit Group

BELOIT EASTERN

CORPORATIO

Downingtown, Pennsylvan

KEEVER VICTOR STARCH

a blend of QUALITY STARCHES made to meet your EXACT requirements

How often do your paper-making problems point the finger to starch problems?

Then get acquainted with Keever — and Victor Starch. It's the only blend of wheat and corn now available to the paper industry.

Tests prove that Victor Blended Starch provides a clearer film, greater adhesive strength, more flexibility, a better fiber lay.

Victor Starch makes it possible to produce a formula best suited to nearly every starch operation in paper making.

Keever starch technicians will help you work out the ideal formula variations that make Victor Starch "custom-made" for individual requirements.

For additional information, write for Keever Data Sheet 170.

THE KEEVER STARCH COMPANY

538 East Town Street, Columbus 15, Ohio

Processors of grain products for industry since 1898

fmc SODA ASH FLOWS "FREE & EASY"

for faster handling

You save time unloading FMC Soda Ash and in getting it from bins or silos into operations.

The reason is simple. FMC Soda Ash is composed of roller-shaped crystals that don't lump up, stick or bridge over. Besides flowing freely, these crystals don't degrade into fines. They make FMC Soda Ash virtually dust-free.

Other features of FMC Soda Ash: Consistently high purity, fast dissolution, low iron and no ammonia content. And you get fast, reliable shipment in our own covered hopper cars.

You can enjoy the advantages of premium-quality FMC Soda Ash and it will cost you no more. Why not ask for our quote?

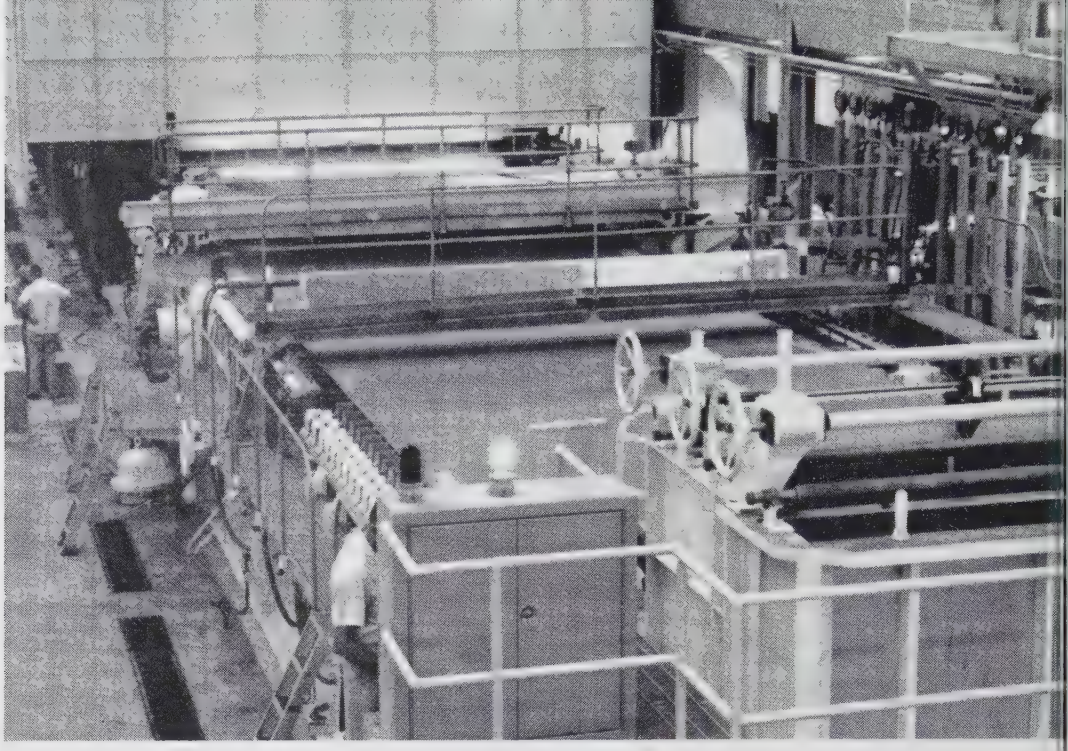
fmc FOOD MACHINERY AND CHEMICAL CORPORATION ®

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

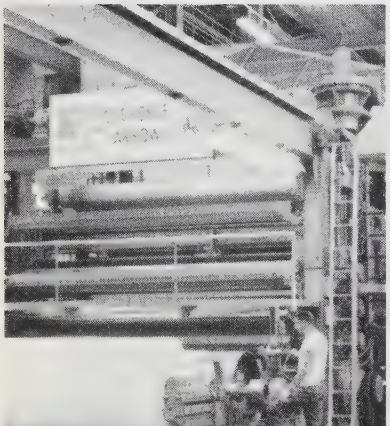
Chlor-Alkali Division

General Sales Offices:
161 E. 42nd STREET, NEW YORK 17



Ecusta Paper Div.
Olin Mathieson Chemical Corp.
Pisgah Forest, N. C.

Performance Proof



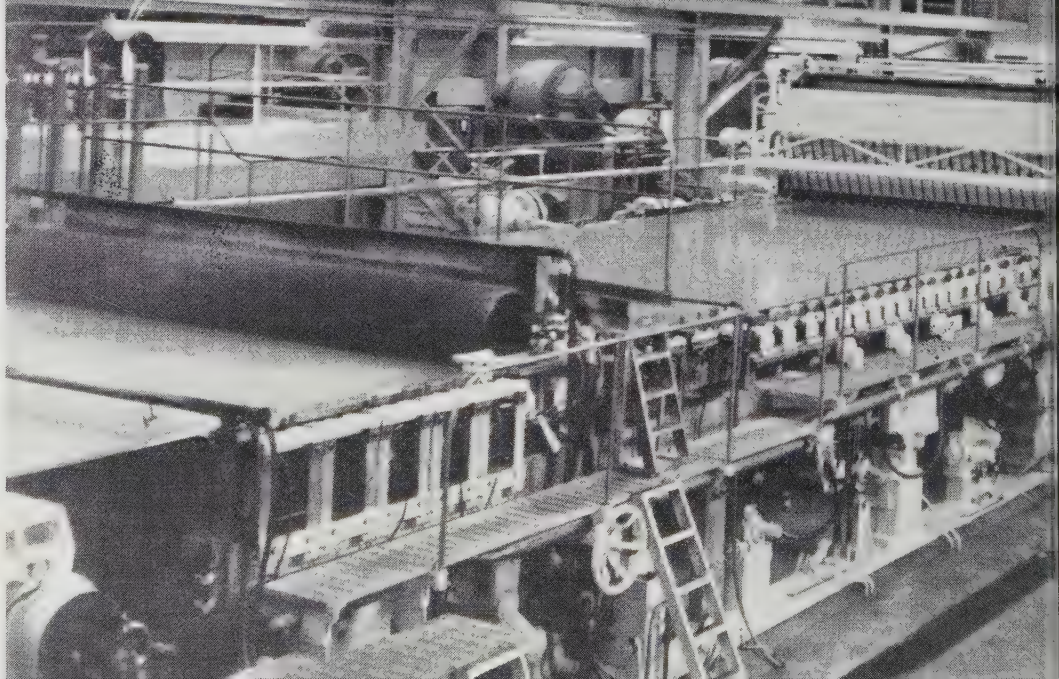
Surpassing even start-up enthusiasm as the biggest, fastest machine for light weight papers, Ecusta's No. 10 has dramatically stepped up both the mill's capacity and its versatility. It is producing up to 55 tons per day of quality-controlled papers in a great variety of weights from 15 to 40 lbs.

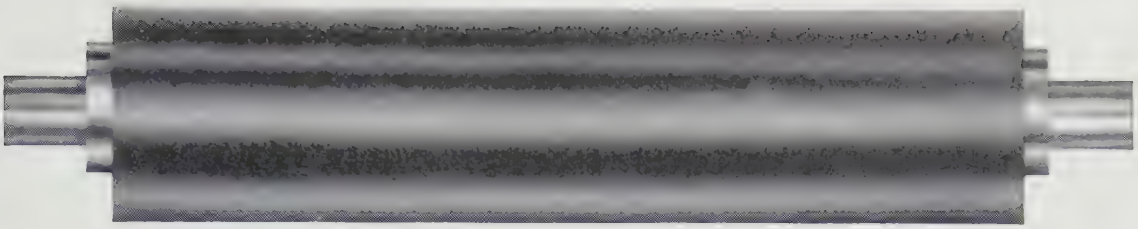
The "Cherokee Arrow" is evidence sound engineering, precision manuf ture and coordination with other equ ment. When planning your next pa machine expansion or modernization, us in to prove what *more* Rice Bar can do for you. *Progress is measu in Results not Claims.*

RICE BARTON Corporation, Worcester, Mas

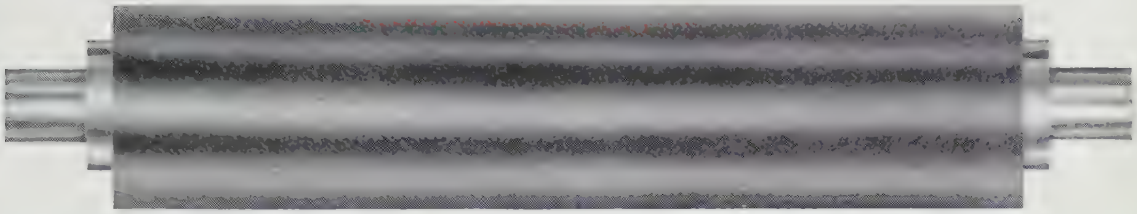
Fourdriniers • Press Sections • Dryer Sections • Calenders and Supercalenders • Reels • Winders • Head Boxes • Size Presses • Breaker S
Differential Draw Control and Cone Pulley Drives • Pulping Equipment • High Velocity Air Dryers • Trailing Blade Coaters • Fibre-Flash Drying Sys

This performance-proven Rice Barton machine has a 182″ removable fourdrinier, a 30′ forming area. Running rate varies from 500 to 850 f.p.m. depending on the weight of the sheet being made. It is driven by a lineshaft through helical gears and differentials for ultimate in draw control. Three dryer sections have 30 high-pressure paper and 4 felt dryers with air-operated felt guides for controlling tension. Breaker stack with hydraulic top roll is located between first and second sections, horizontal size press between second and third. Moisture is controlled to correct for curl before sheet enters calender stacks and reel. Constant tension on winder is maintained by another differential drive.

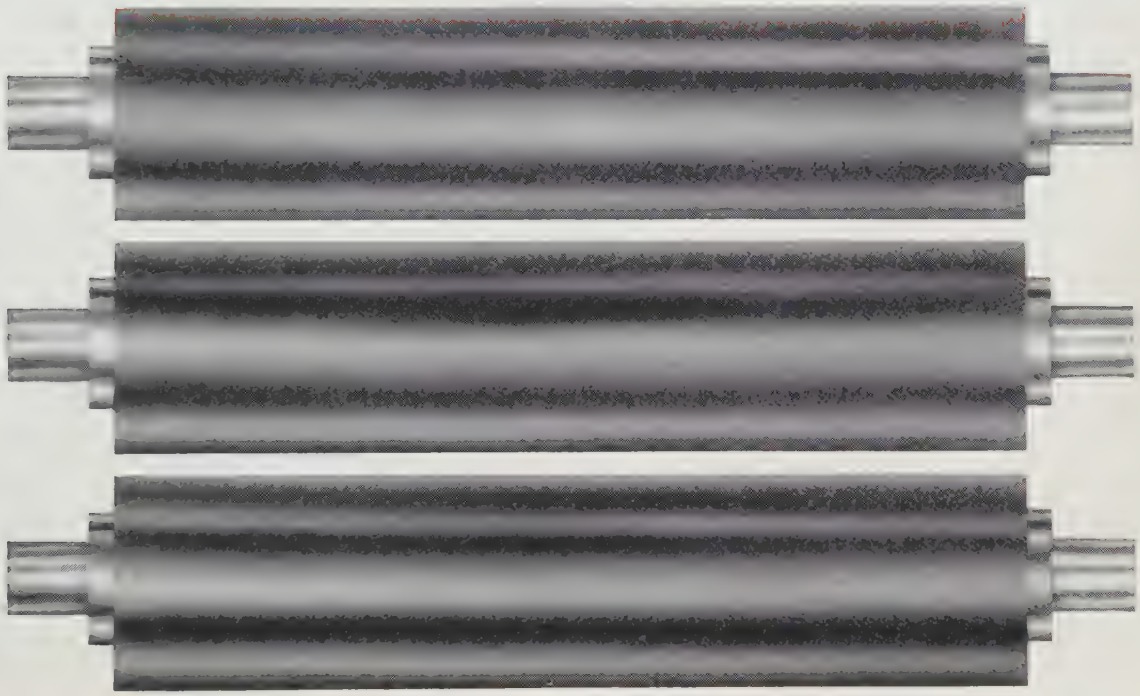




for uniform smoothness
plus consistently good results



PRESKOTE® COATING ROLLS



Over a dozen S-W covering formulations for coating enable your S-W Sales Engineer to recommend the best combination of properties for each position. Call him about your problems.

75th YEAR S-W INC.

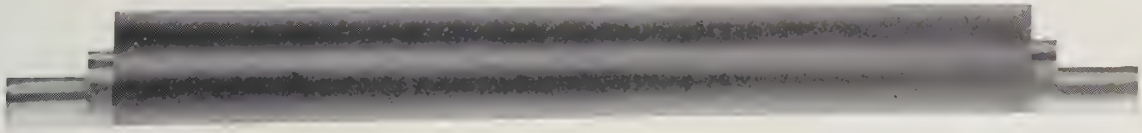
more tons from every cover because of technical leadership

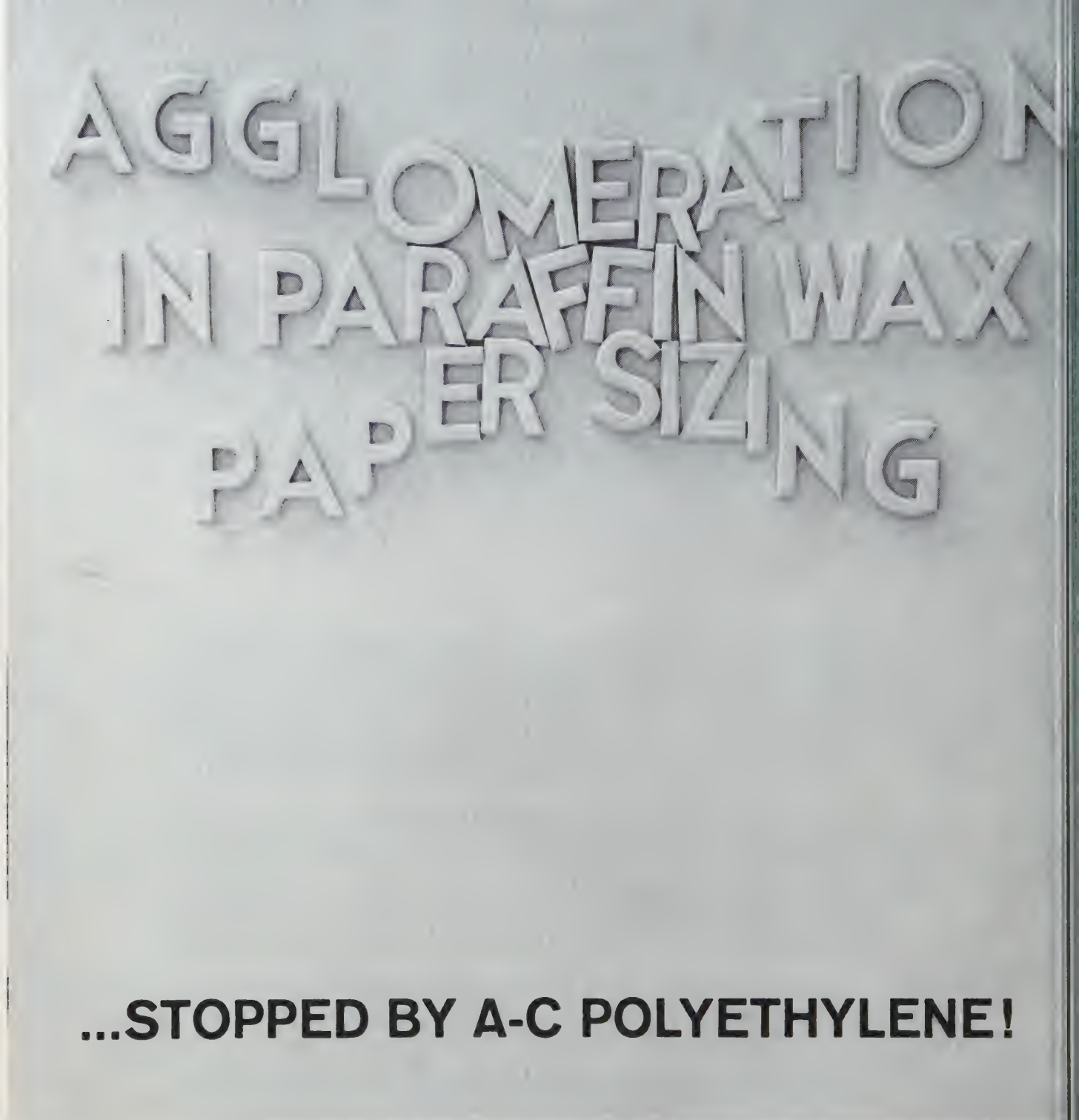
STOWE-WOODWARD, INC.

NEWTON UPPER FALLS, MASSACHUSETTS • NEENAH, WISCONSIN • GRIFFIN, GEORGIA

on the West Coast **HUNTINGTON RUBBER MILLS, INC.**

SEATTLE, WASHINGTON • PORTLAND, OREGON • PORT COQUITLAM, BRITISH COLUMBIA, CANADA





...STOPPED BY A-C POLYETHYLENE!

Recent lab studies show that A-C® Polyethylene in paraffin wax sizings *improves the particle size of the emulsion*. It stops agglomeration by raising the softening point of paraffin. And it gives the emulsion greater mechanical stability.

Now you can have superior sizings for all types of papers, from writing to wrapping. A-C Polyethylene not only keeps emulsion particles properly dispersed—it contributes gloss, toughness, and resistance to water and chemicals.

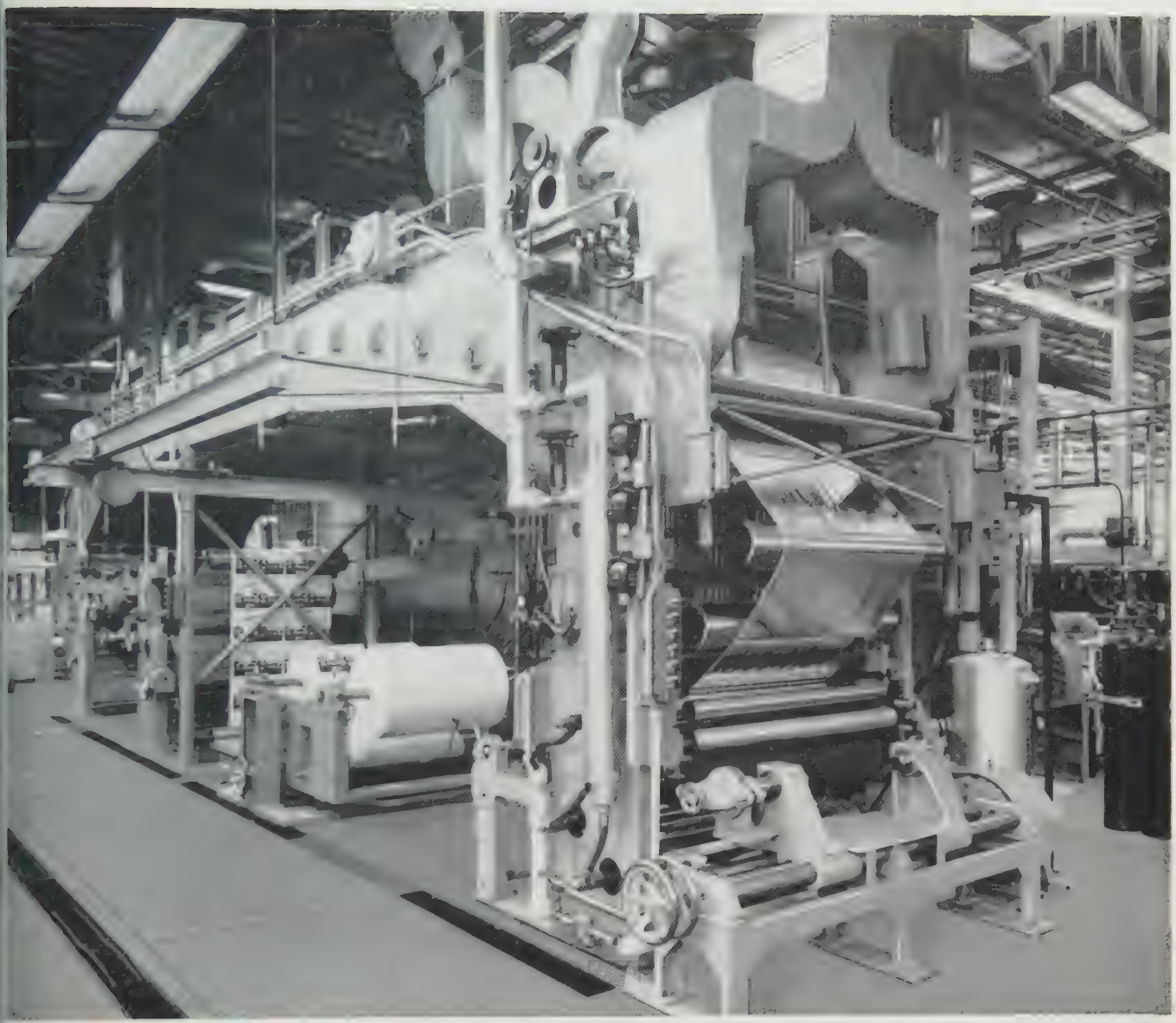
You'll find A-C Polyethylene easy to incorporate into your regular emulsifying procedure. Or you can ask your supplier for emulsions containing A-C Polyethylene.

For technical data, write: Plastics Division, Dept. 614-T, 40 Rector Street, New York 6, N.Y. In Canada: Allied Chemical Canada, Ltd., Montreal.

PLASTICS DIVISION
40 Rector Street, New York 6, New York

Allied Chemical

BASIC TO AMERICA'S PROGRESS



Inta-Roto GM-2000 Laminator Expands Western-Waxide Facilities

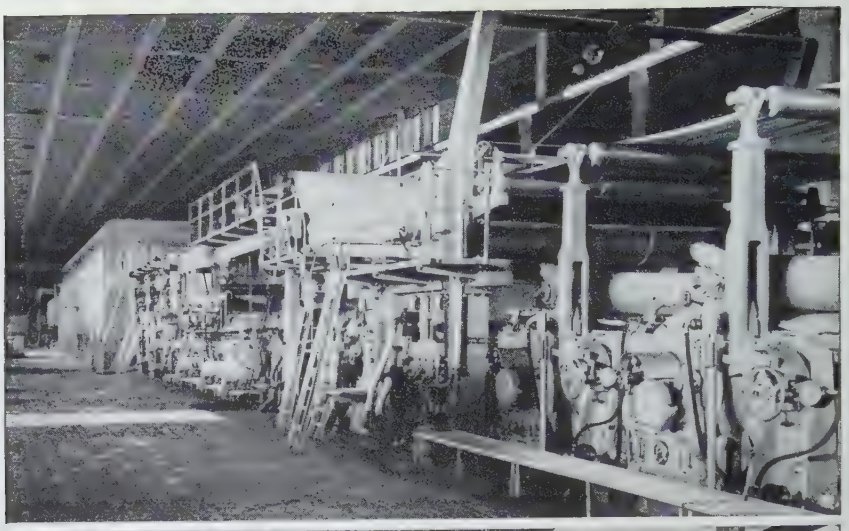
Above is an actual photo of the Inta-Roto GM-2000 Laminator in use at Western-Waxide Division, Crown Zellerbach Corporation, San Leandro, California, headquarters plant. David J. Benjamin, Vice-President of the company, had this to say about the GM-2000: "This machine is the finest of its kind for the production of high precision laminated and/or coated flexible packaging materials.

"With this new laminator, Western-Waxide will be able to both adhesive and wax laminate foil to paper and/or board up to 54" in width, either polycoated or plain. We will also be able to wax or lacquer coat, dry bond transparent film to foil and hot stretch laminate films."

Since the installation at Western-Waxide, GM-2000 Laminators have been installed at Kaiser Aluminum & Chemical Corp., and R. J. Reynolds Tobacco Co. An early prototype is in use at Milprint Inc. The GM-2000 is constructed on a unit basis and can be modified to meet your requirements.

INTA-ROTO MACHINE CO., INC.

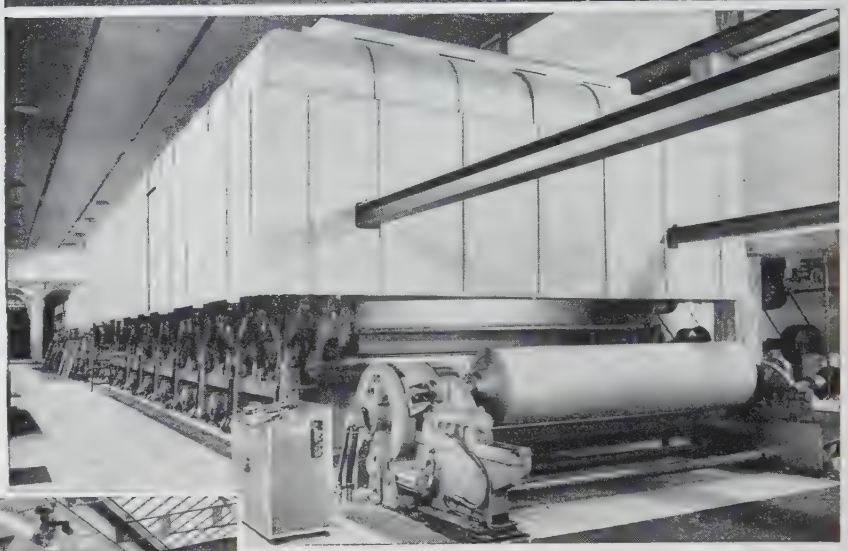
P. O. BOX 454, BYRD AIRPORT, RICHMOND 3, VA.
PHONE REPUBLIC 7 4181



1 The largest fine board machine in Europe.

2 Machine for superfine papers with extra great working width for the manufacture of thin papers.

3 Automatic pick-up machine designed for highest working speeds, making pulp wadding, hygienic and M.G. papers.



Three

particularly successful designs

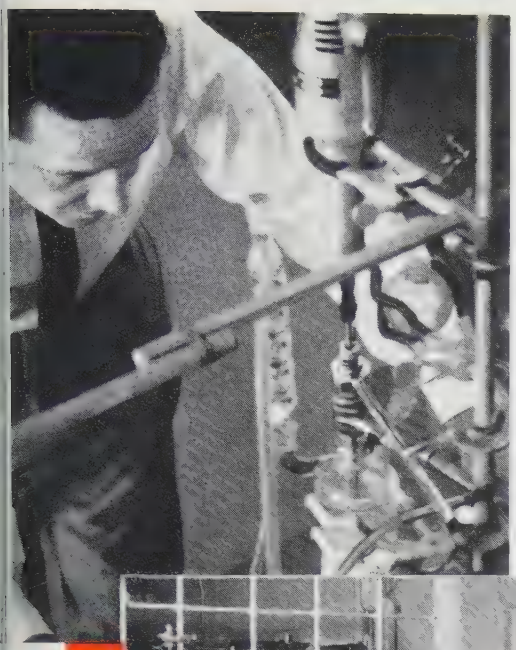
from our versatile program
for the paper and board industry

O. DÖRRIES A.G. DÜREN

Eisengießerei und Maschinenfabriken · Western Germany

Agents: Bulkley, Dunton Pulp Company, Inc. 295, Madison Avenue, New York 17, N.Y./USA

Telephone: Murray Hill 9-6400 Telex: TWY-NY 1-2092



MARBON

Starting point
*for the finishing touch**
that makes your
product BETTER . . .

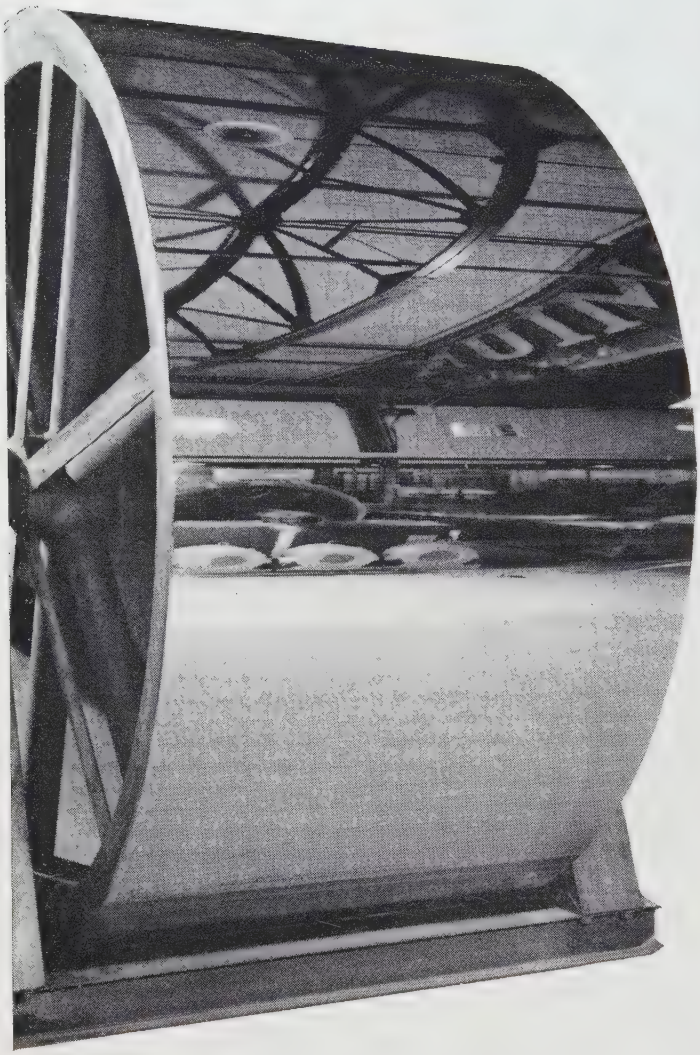
*Marmix®
RESIN & RUBBER LATICES

BETTER PAPER PRODUCTS—you can make them today, at lower cost with MARMIX Latices. Used as saturants or additives, they make stronger, tougher products—provide extra resistance to tear and delaminations, insure greater protection against moisture, grease, oils and chemicals. You must try it to know it. Samples and technical assistance are yours for the asking. Write Dept. Y-9

MARBON CHEMICAL WASHINGTON — DIVISION **BORG-WARNER** WEST VIRGINIA

FINISH...

the prelude to PERFORMANCE



This dryer drum 12' D x 75" Face is CRODON-plated directly upon steel for hardness and durability.

The performance of your dryer drums deserves that extra fineness of best-surface-finish which vitally affects the quality of the paper you sell. There is more than simple help to be gained in your production from CRODON-plating—there is the more direct benefit of improved quality of your paper that helps your product in the market place.

For more than 30 years CRODON-plating has been applied to drum surfaces to provide operating efficiency and lowered long-range costs. These years of experience emphasize five of the benefits of the CRODON surface **finish** and its contribution to your machine **performance:**

Cleanliness	Assures freedom from rust and consequent staining.
Hardness	Gives economical long life through its durability and wear resistance.
Thermal Suitability	Provides uniform and high-performance conduction heat-transfer.
Adaptability	Enables select textured or mirror finishes tailored to product requirements.
Imprint	Fulfills a need for better finishes imparted to paper, a boost in quality for you to market.

Need this kind of help? Invite the CRODON man

CRODON
The Chrome Plate
TRADE MARK REG. U.S. PAT. OFF.

Behind every CRODON application are the resources, experience and reputation of America's oldest, largest and most progressive industrial chromium plating organization.

CHROMIUM CORPORATION of AMERICA

Plants at:

Waterbury 20, Conn.
P. O. Box 1229

Chicago 51, Ill.
4645 W. Chicago Ave.

Cleveland 5, Ohio
8701 Union Ave.

FLEXIBLADE
COATERS

Partial list of customers who have purchased a Black-Clawson Flexiblade® Coater for pilot or commercial operation

BATHHURST POWER & PAPER CO. / CANADIAN INTERNATIONAL PAPER COMPANY CROSSETT PAPER MILLS — RESEARCH DIVISION / DEWEY & ALMY CHEMICAL DIVISION, W. R. GRACE & CO. / THE DOW CHEMICAL COMPANY / INTERNATIONAL PAPER COMPANY / THE KVP COMPANY LIMITED / NEWTON FALLS PAPER MILL, INC. NEW YORK & PENNSYLVANIA CO., INC. / OLIN / RIEGEL PAPER CORPORATION

plus many other leading companies here and abroad.

DILTS DIVISION
Fulton, New York
CONVERT WITH CONFIDENCE

BLACK-CLAWSON

CHELONS* IN PULP BLEACHING
**pronounced "key-lons"*

Chelon-80

IMPROVES BRIGHTNESS STABILITY OF BLEACHED GROUNDWOOD... SAVES AS MUCH AS $10 TO $12 PER TON ON BEATER FURNISH

The improved brightness stability of bleached groundwood reduces the quantity of bleached sulphite in the beater furnish from 20% to 5%. In other cases, it completely eliminates the need for bleached chemical pulps. In addition, there are savings in chemical costs. At the same time, "off-machine" brightness holds up within specifications Brightness Stability — from storage through the machine is the reason why CHELON-80 justifies its use in any groundwood bleaching system.

Attention is now focused on the role played by metal ions such as iron, copper, manganese and nickel in pulp purification processes. Decomposition of bleach liquors, degradation of cellulose and color reversion are simple manifestations of metallic ion catalysis. Selective chelation to prevent this catalytic action calls for CHELONS.

CHELONS at work in pulp slurry neutralize metal ions just as a base neutralizes an acid. The chemistry may become involved but that is where our technical know-how and experience can help. We offer the service of Mr Andrew J Gard on all applications of CHELONS in pulp and paper production.

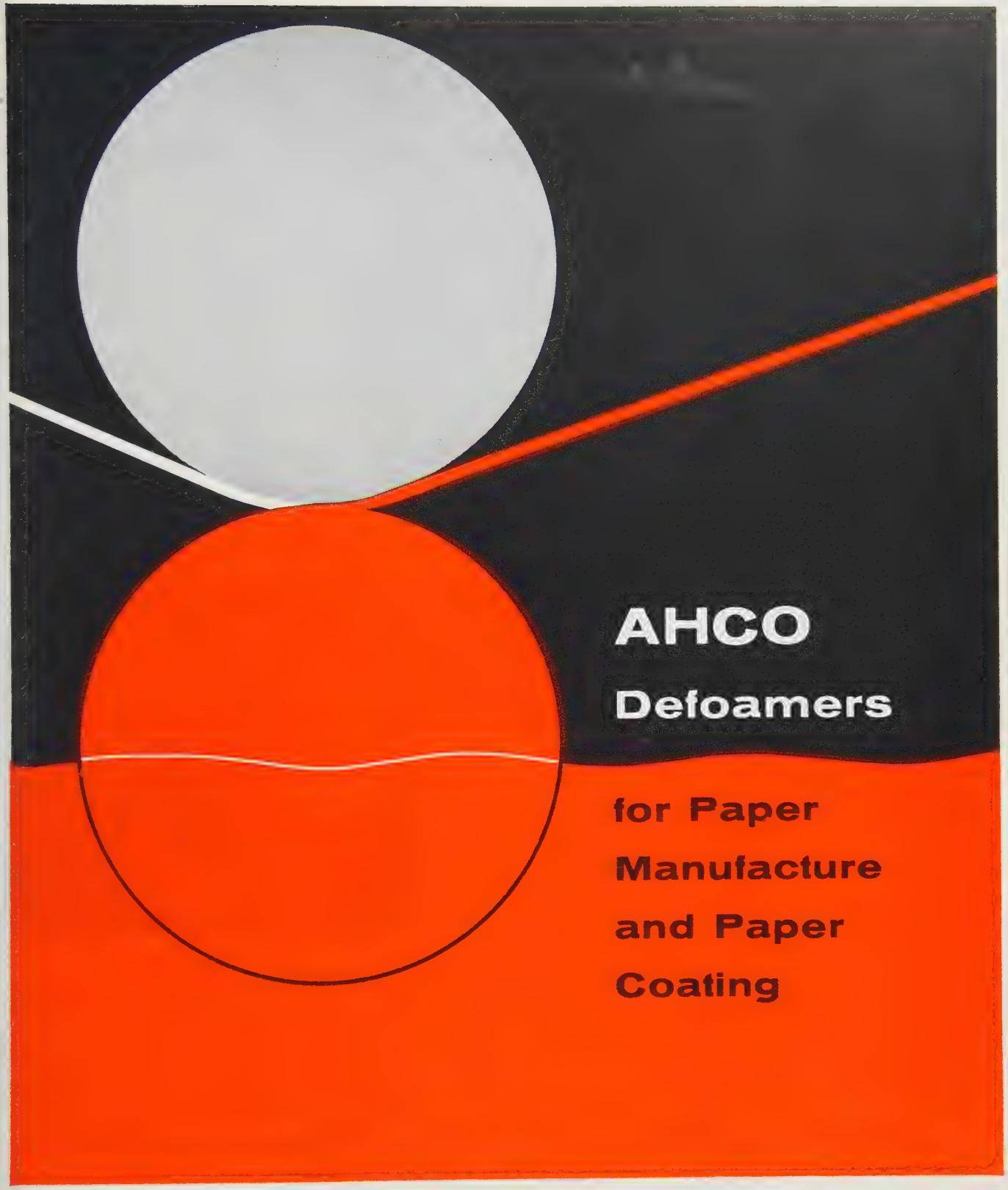
In mechanical and chemical pulp production CHELON-80 and CHELON-100 do these things:

1. Improve grinding efficiency of the stone.
2. Control pitch in both mechanical and chemical pulps.
3. Deactivate metal ions prior to peroxide, hypochlorite and chlorine dioxide bleaching.
4. Prevent color reversion.
5. Chelate iron in specialty papers.
6. Inactivate iron in conjunction with optical dyes.
7. Inactivate metal ions in dyeing of paper

Ask for the real story on chelating agents in pulp bleaching. Write today

CHELATE CHEMICALS corporation

11 BEACON STREET, BOSTON 8, MASSACHUSETTS



A COMPLETE RANGE of defoamers for virtually every foaming problem. Highly stable defoamers for hard water conditions, easily emulsified liquids, pumpable pastes for bulk handling. FDA approved defoamers to meet rigid specifications.

For assistance with specific foaming problems call on your AHCO representative.

Quality AHCO PRODUCTS Integrity

Manufacturers of optical brighteners, coating additives, defoamers and other chemical specialty products for the paper industry.

ARNOLD, HOFFMAN & CO. INCORPORATED

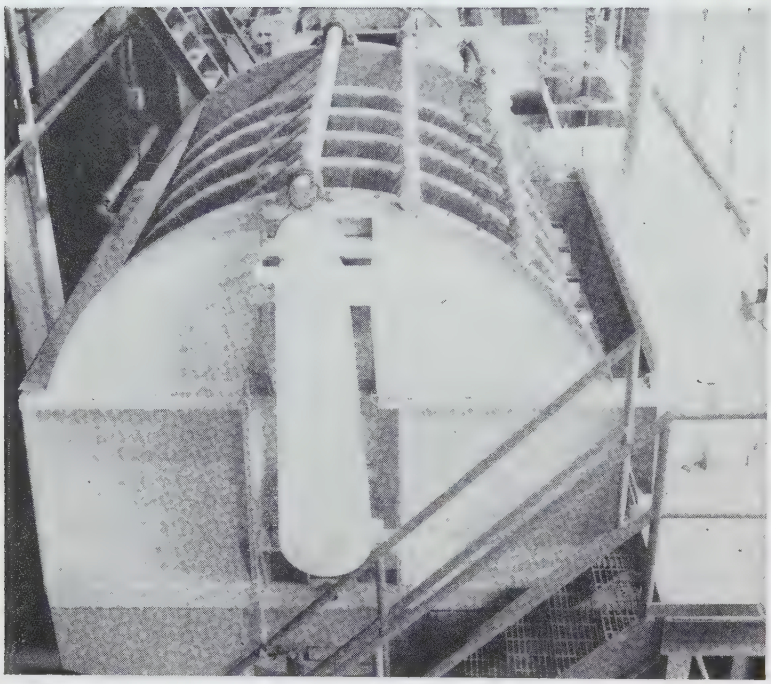
55 Canal Street, Providence, Rhode Island • Est. 1815
A Subsidiary of Imperial Chemical Industries Limited, England
West Coast Representative: Chemical Manufacturing Company, Incorporated of California

221-1

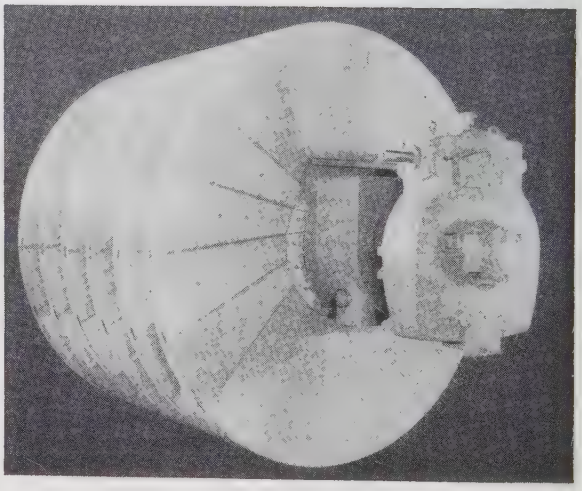
NEW IMPCO

Disc Type Filter Design

At Scott Paper Company, Mobile, Alabama



Molded Discs and One-piece Stainless Core Raise Capacity and Clarity Standards — Due to New Hydrodynamic Design Concept.



Close up your white water system with the new Impco Disc Filter! This saveall concept, with its molded sectors and one-piece stainless core, is a fresh approach to disc type filtering. Hydrodynamic design and latest materials now give you a truly ultramodern filter.

Swept back, molded, lightweight, bonded-face sectors increase capacity and wire life. Contra-flow inlet eliminates pulp thickening in vat. Eighteen ported trunnion and full 180° valve opening produce sharpest filtrate separations. Speeds from ¾ to 4.5 R.P.M. Ask your Impco Sales Engineer for full information and write for Bulletin A5-1.

Above: Six-disc unit minus vat, showing valve and dual filtrate discharge. Filters available in sizes up to sixteen discs. Keyed aligning and attaching device makes assembly of a complete disc the simplest yet. A complete disc consisting of eighteen 22 pound sectors is assembled in one hour.

IMPROVED MACHINERY INC. NASHUA, NEW HAMPSHIRE

IMPCO®

IN CANADA: Sherbrooke Machineries Limited, Sherbrooke, Quebec

NOW! FOUR

new aids to making paper

NEW derivatized starches for high density pigmented coatings

NEW high fluidity starch products to replace synthetic latices partly or wholly

NEW Tricon Process for making waterproof adhesives

NEW better, low-cost continuous starch cooker

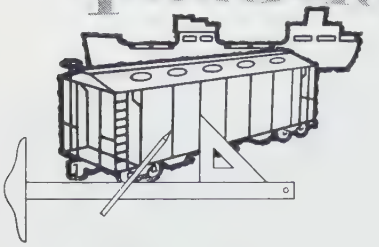
. . . Fruits of an ambitious research program that provides a continuing flow of new processes, new products and new applications. *To keep up with the latest in paper technology, keep in touch with Penick & Ford.*

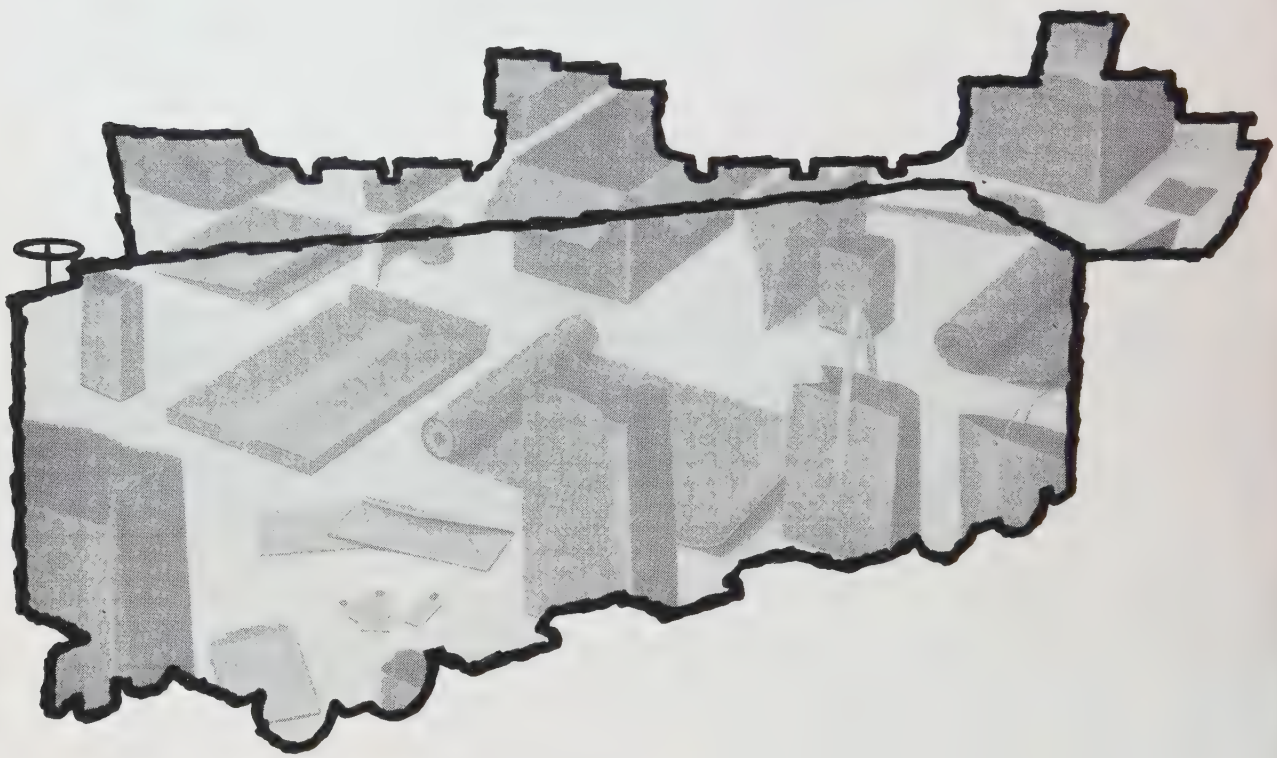
PENICK & FORD, LTD.
INCORPORATED

750 THIRD AVENUE, NEW YORK 17, N. Y.
1531 MARIETTA BLVD., ATLANTA, GA.
CEDAR RAPIDS, IOWA
333 MARKET ST., SAN FRANCISCO 5, CALIF.

WEST END

advance planning OF ECONOMICAL SALT CAKE TRANSPORT ANTICIPATES INDUSTRY'S GROWING NEEDS





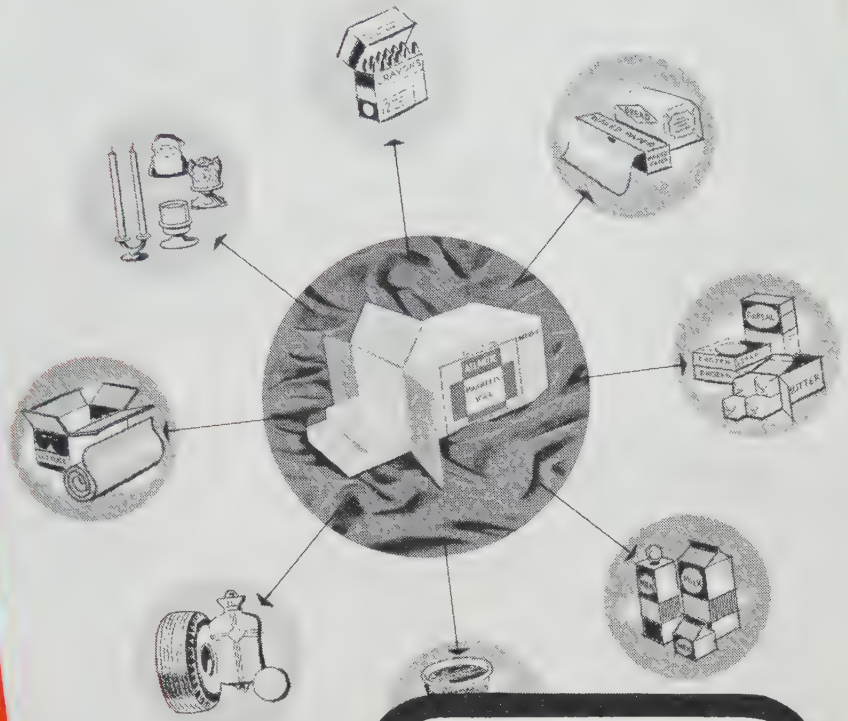
WEST END program of utilizing economical water transport and new Jumbo hopper cars with 60% additional capacity enables West End to move salt cake at great distances economically. With a vast natural raw material supply and large, expanding production capacity, West End is solidly qualified as a major supplier to handle the complete requirements of its customers dependably, economically and efficiently within a wide geographical area.

Stauffer CHEMICALS

WEST END CHEMICAL COMPANY • DIVISION OF STAUFFER CHEMICAL COMPANY

636 CALIFORNIA STREET, SAN FRANCISCO, CALIFORNIA • PLANT: WESTEND, CALIFORNIA

AN ATLANTIC WAX FOR EVERY USE



FREE for your files...

A helpful NEW 24-page guidebook for all users of paraffin waxes

Whatever your individual requirements, you're sure to find information of value to you in this new Atlantic guidebook. This is because Atlantic offers a complete line of waxes covering every industrial need.

The booklet describes petroleum waxes and their uses... discusses wax properties such as gloss, grease resistance and sealing strength... provides a handy chart of recommended waxes for specific purposes from acid bottles to woodwork finishing... and more!

Of particular interest is the section devoted to waxes and types of waxing used in the paper coating industry. Here, for example, you will find the proper blend for a hard, glossy surface, advantages of waxed corrugated cartons over wooden crates, and descriptions of wet, dry and laminated waxing operations.

To receive your free copy of the booklet, simply fill in and return the coupon below. And if you'd like more detailed information on any Atlantic wax or blend, get in touch with your Atlantic Sales Engineer. No obligation, of course.

THE ATLANTIC REFINING COMPANY
Industrial Products Division
260 South Broad Street, Philadelphia, Pa.
Please send me—without obligation—a copy of your new 24-page guidebook, "An Atlantic Wax for Every Use."

Name_____

Title_____

Firm Name_____

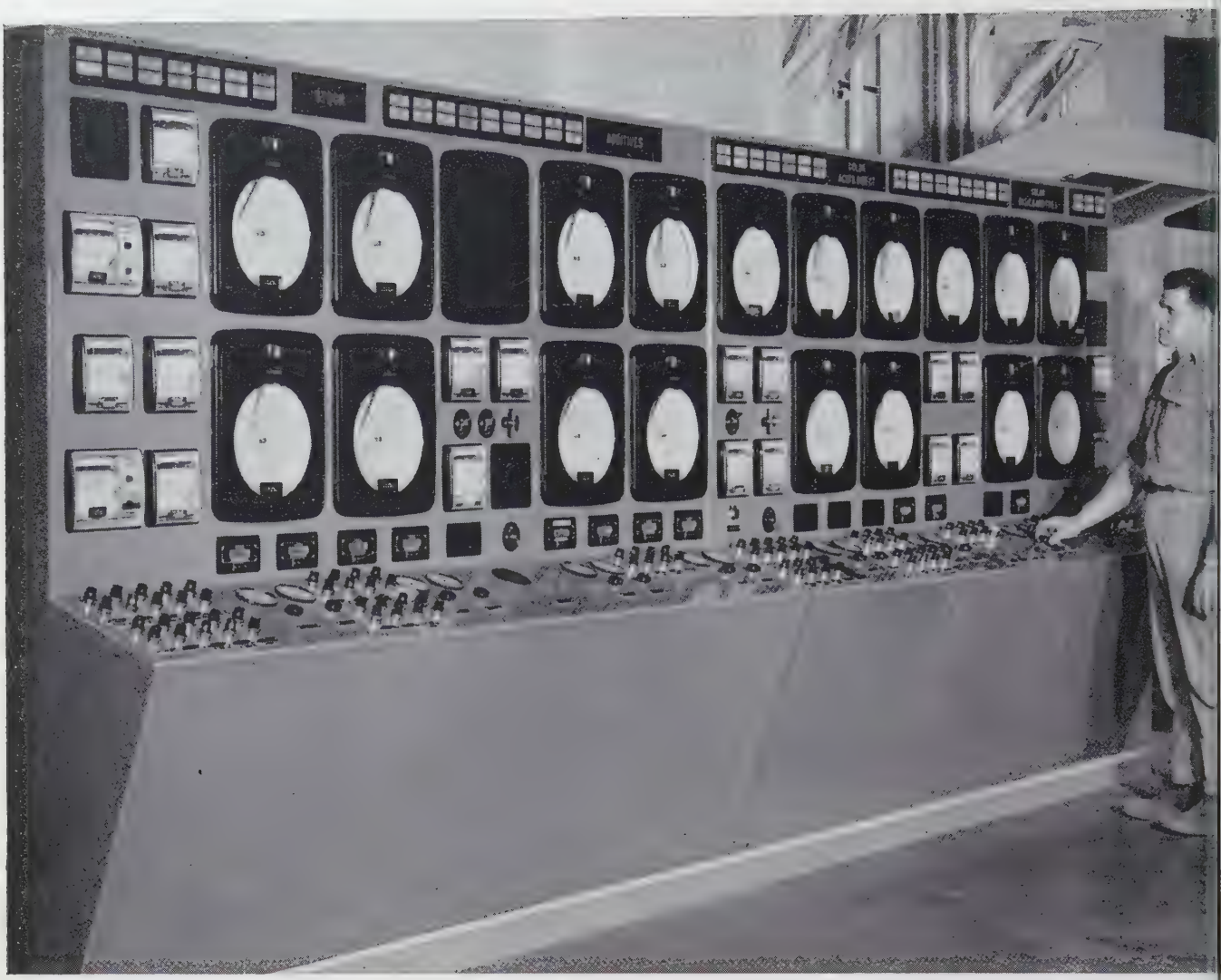
Address_____

City_____ Zone____ State_____

WAXES • LUBRICANTS • PROCESS PRODUCTS

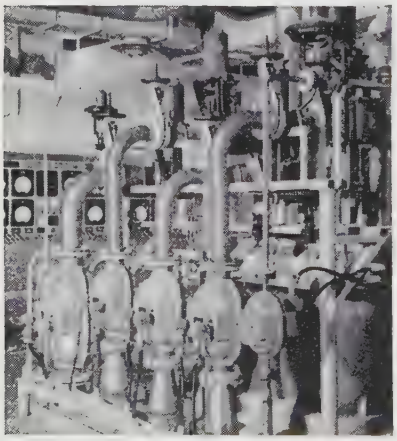
Philadelphia, Pa. • Providence, R. I. • Syracuse, N. Y.
Pittsburgh, Pa. • Charlotte, N. C.

ATLANTIC



Foxboro Stock Blending Control Panel for Fraser Paper's new No. 7 bond machine at Madawaska, Maine. The system precisely ratios the flow of four stocks, six additives, as well as dyes and alum.

Foxboro Stock Blending Control System had Fraser Paper producing saleable paper the first day they started their new bond machine



Foxboro Magnetic Flow Meters, ½", 1", 4", and 6" diameter, measure the flow of stocks and additives to blending chest with an accuracy of better than ±1%.

Excellent performance right from start-up has been provided by the Foxboro stock blending control system at Fraser Paper Limited, Madawaska, Maine. Day after day, their Foxboro control system is producing consistent, uniform furnish for Fraser's new No. 7 bond machine.

Fraser is averaging several grade changes a day on this machine, many involving changes of furnish. But the operators find it easy to change furnishes with the Foxboro Blending System. They just set the desired stock, dye, and additive ratios. Then, Foxboro automatically blends stock, dyes, and additives — and controls stock consistency, pH, mixing time, and chest level as well. The system even adjusts for changes in machine demand while holding all proportions exactly constant.

The result — perfect furnish uniformity for Fraser's No. 7 machine.

Your mill can benefit, too, from the cost-cutting high performance you get right from start-up with Foxboro Stock Blending Control Systems. Write for full details. The Foxboro Company, 789 Neponset Ave., Foxboro, Mass.

FOXBORO

REG. U. S. PAT. OFF.

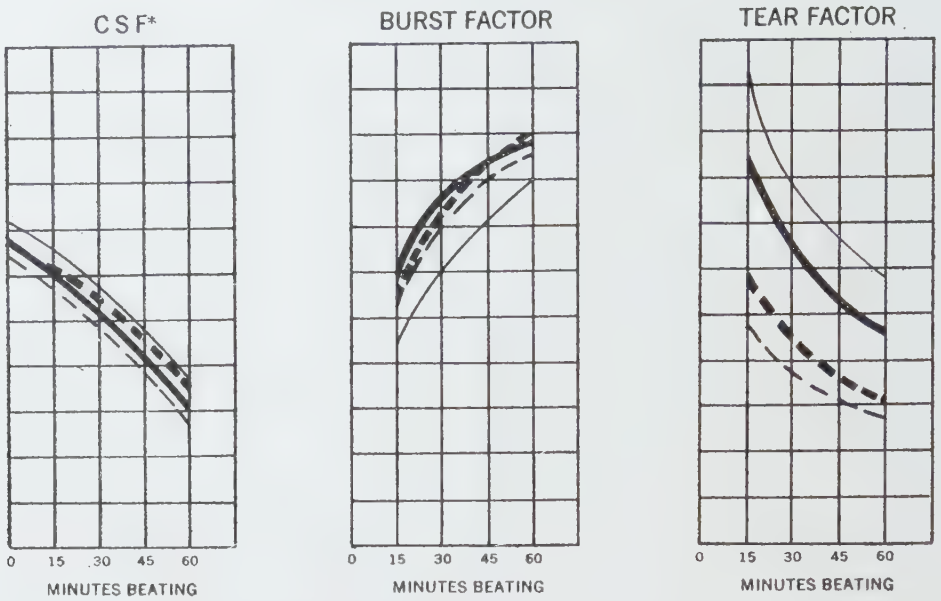
Disc REFINERS

Write for descriptive Bulletins . . .
SPROUT, WALDRON & COMPANY, INC. • MUNCY, PENNA.

U.S.A.

CELGAR KRAFT HAS BALANCED PROPERTIES

STRENGTH VALUES



*Canadian Standard Freeness

As shown by the above graphs, Celgar Kraft compares favourably with the world's best prime bleached kraft pulps in standard pulp tests.

In the all-important beating time to required papermaking freeness, it develops faster than other typical Canadian bleached kraft pulps, comparing favourably with the fast-beating Scandinavian furnish. This feature means high-volume output from repulping equipment at reduced power cost.

The bursting resistance of prime bleached Celgar Kraft exceeds or compares favourably with the best of its competitors while it is excelled only by West Coast bleached krafts in tearing resistance.

This unique and outstanding balance of properties at a high level can be achieved because of the Interior grown tree species used, the climatic conditions under which they grow and the modern process equipment installed in the new Celgar mill. These pulping characteristics, coupled with low beating time and good printability, place Celgar Kraft among the best bleached kraft pulps available in the world.

Distributors and agents for:

Celgar Kraft Pulps and Columbia Cellulose Viscose, Acetate and hardwood and softwood specialty sulphite paper pulps.

Canada and United States
(*kraft and sulphite pulps*)
Columbia Pulp Sales Limited,
1600 Dorchester Street West,
Montreal 25, P.Q.

France
(*kraft and sulphite pulps*)
Ekman & Cie,
36 Bld. Haussmann,
Paris 9, France.

England
(*kraft and sulphite pulps*)
Columbia Pulp Sales Limited,
49 Old Bond Street,
London, S.W. 1.

Italy
(*kraft pulps*)
Rappresentanza Ekman,
Cellulose Tvedesi,
Via Manzoni,
Milan, Italy.

Germany
(*kraft and sulphite pulps*)
Canadian Forest Products GMBH,
Königstrasse 10B,
Stuttgart N, Germany.

Italy
(*sulphite pulps*)
W. Pauly & Co.,
Via Vittor Pisani, 5,
Milan 508, Italy.

For information regarding other overseas agents please direct request to:
1600 Dorchester Street West, Montreal 25, P.Q.

COLUMBIA PULP SALES LIMITED

V6834-1

"This pump swallows paper stock whole

Its impeller shows you why.

The Model 3135 has an open, end suction, non-clogging impeller. Stock flows easily into its big eye, pushed along by inlet vane tips, warped to give a screw conveyor effect. The warped vanes also prevent water separation of stock, without supplemental feeding mechanisms.

Nothing catches at the eye—no fibres, strings, or other material—because there is no nut or other obstruction there. Internal lock nuts hold the impeller to the shaft flange.

Stock can't jam between the back impeller wall and the stationary side plate since both ejector and main vanes follow the same curve.

Longer packing life. Pump-out vanes on the impeller back also reduce pressure on the stuffing box for a greatly extended packing life.

Restore clearance easily. When wear occurs between impeller and suction side plate, simple external adjustment moves shaft and impeller axially towards suction side plate.

Free bulletin gives performance curves of Model 3135, an illustrated step-by-step description of the fast removal of the rotating element, specifications, and other useful information. Ask for Bulletin 723.1.

Goulds Pumps, Inc., Dept. TA-91, Seneca Falls, New York.

GOULDS PUMPS

DOW

pulp processing chemicals

MAGNESIUM HYDROXIDE SLURRY

MAGNEFITE PULPING GIVES HIGHER STRENGTH AND YIELDS, SHORTER COOKS, THROUGH A WIDER RANGE OF WOODS

A significant improvement over earlier magnesium-base pulping process, the Magnefite process permits a greater range of wood species to be pulped . . . in shorter cooking cycles . . . producing excellent pulp at higher strength and brightness with better yields. Magnefite pulping may be combined with a highly efficient commercially proven heat and chemical recovery process.

The Magnefite process has been successfully applied to a wide variety of woods—jack pine, tamarack, white pine, birch, elm, poplar, maple, and other difficult-to-process woods—permitting a lower cost/ton of pulp produced.

Processing advantages are numerous. Cooking cycles are shorter since there is no limit to the speed at which the temperature of the digester can be raised. The absence of large quantities of SO_2 gas in the digester permits cooking at higher temperatures. A rapid increase in temperature is also possible as a result of impregnating pulpwood chips with hot magnesium bisulfite liquor of equal combined and free SO_2. With such rapid penetration of chips, cooking time is reduced as much as 40%! This results in a substantial increase in digester capacity. The absence of true free SO_2 simplifies liquor make-up, eliminates the need for pressure storage vessels, and practically does away with dry relief.

In some cases, the cost and processing advantages of Magnefite pulping justify its use even without chemical recovery. Where chemical recovery is justified, 90 percent of the pulping chemicals may be reclaimed and reconstituted in a recovery system.

Dow is a basic supplier of the principal ingredient, magnesium hydroxide . . . in slurry form for maximum handling ease . . . available for immediate delivery. Chances are Magnefite pulping can be an advantage in your processing operation. Write THE DOW CHEMICAL COMPANY, Midland, Michigan, Chemicals Sales Department 802FC9, for further details.

THIRTEEN LOCATIONS COUNTRY-WIDE ASSURE PROMPT DELIVERY OF DOW CAUSTIC SODA

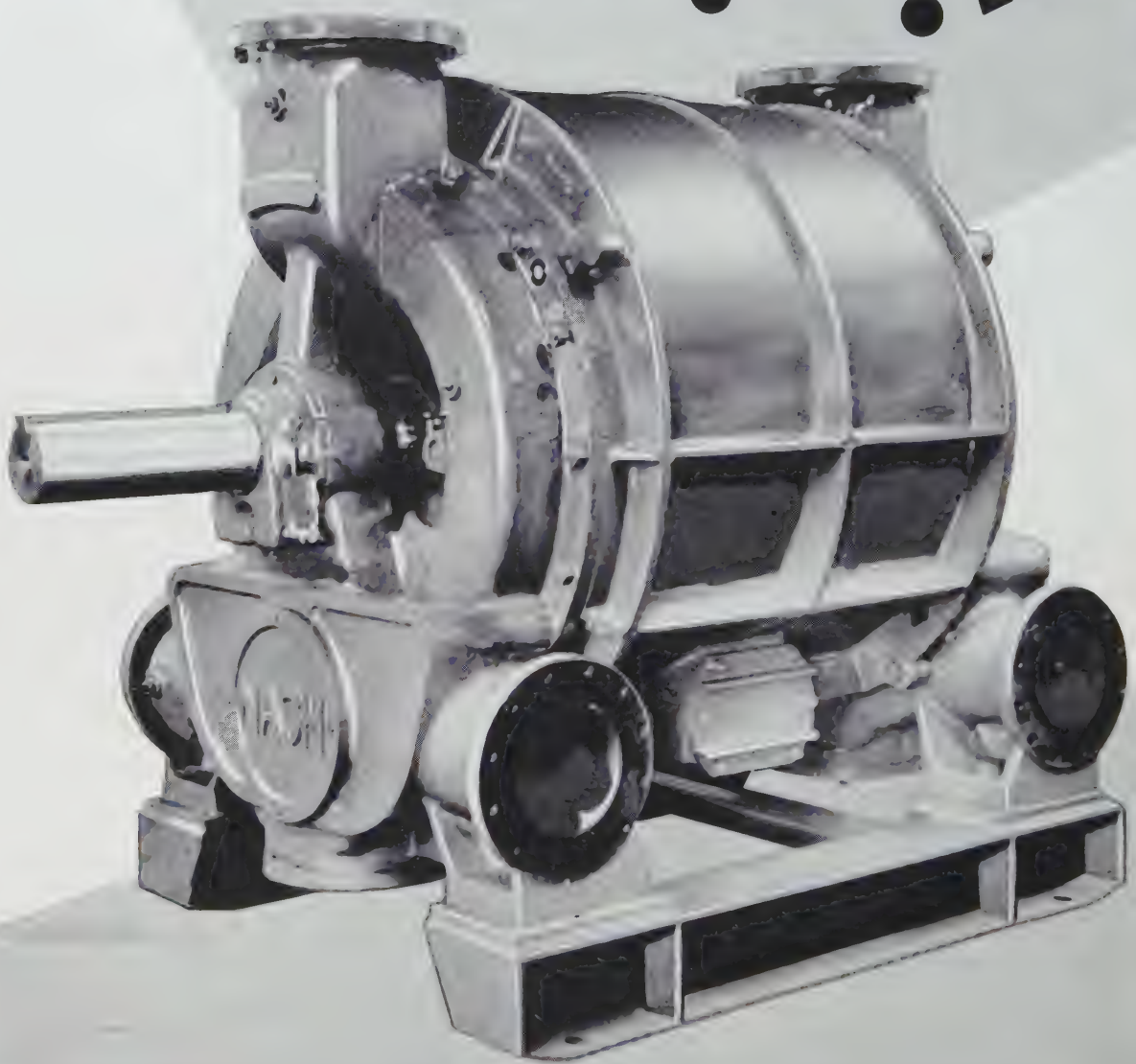
To serve you better, Dow Caustic Soda Solution 50% is available when, where, and how you want it from thirteen shipping points throughout the country. Fast delivery is assured via tank car and tank truck from four producing plants—Midland, Mich.; Freeport, Texas; Plaquemine, La.; and Pittsburg, Calif.; plus nine terminals—N. Charleston, S. C.; Carteret and Bayonne, N. J.; Denver, Colo.; Grants, N. Mex.; Chicago, Ill.; Los Angeles, Calif.; St. Louis, Mo., and Baltimore, Md. All provide tank truck and tank car shipments. For more information, call your nearest Dow Sales Office or write THE DOW CHEMICAL COMPANY, Midland, Michigan.

THE DOW CHEMICAL COMPANY DOW Midland, Michigan

a new NASH

designed for

- HIGH PERFORMANCE
- RELIABILITY
- LOWER
-



VACUUM PUMP

INVESTMENT
REDUCED OPERATING COSTS

- Vacuums to 25″ of Mercury with sustained volume and lower horse power. Available in capacities to 9000 cubic feet.

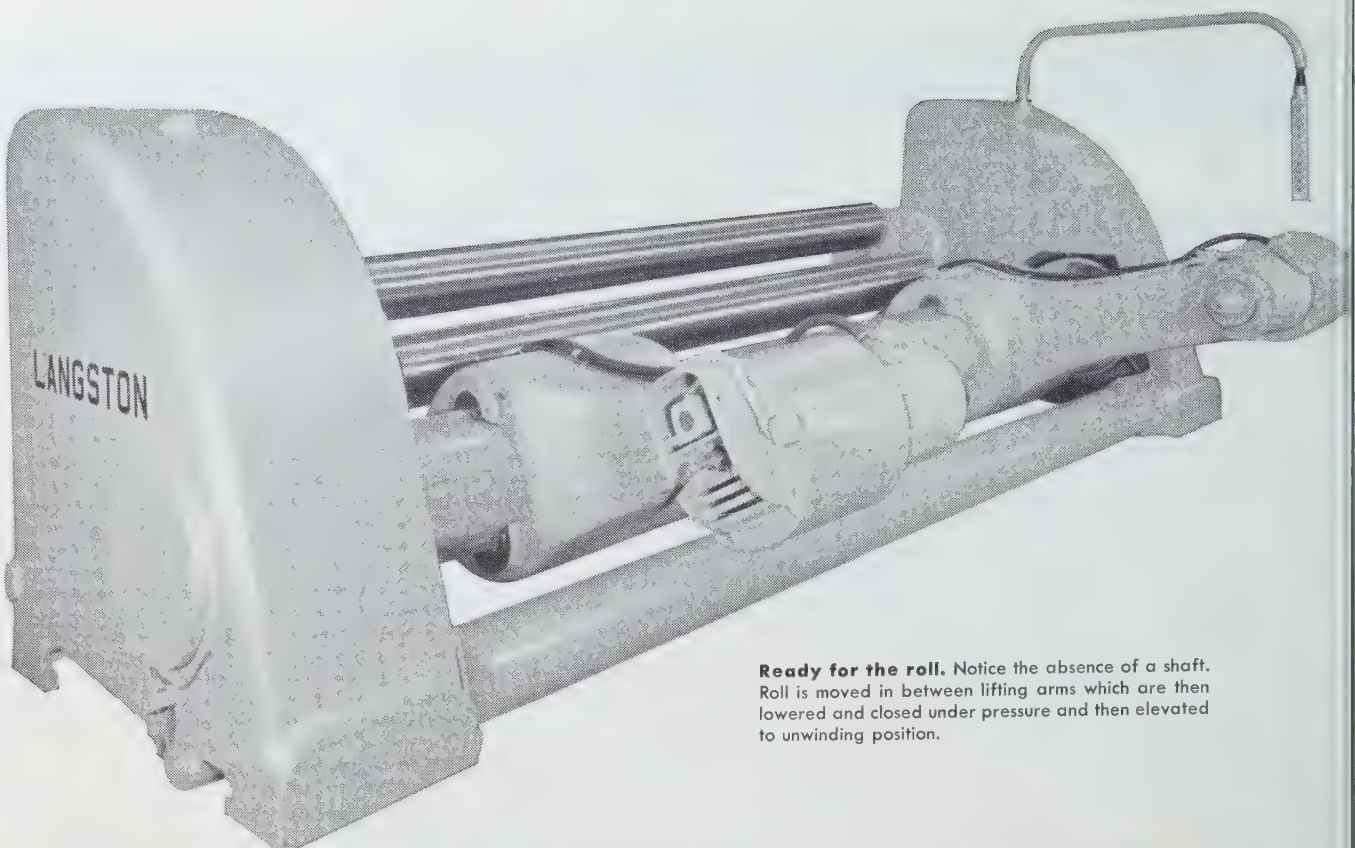
Can be supplied with integral reduction gear for direct connection to high speed motors.

Material reduction in floor space required.

Send now for details of the new 6000 series Nash Vacuum Pumps.

NASH ENGINEERING COMPANY

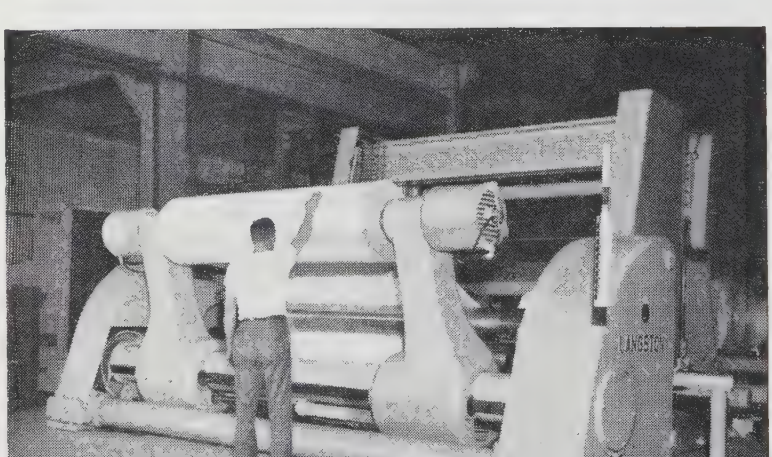
SOUTH NORWALK, CONNECTICUT, U.S.A.



Ready for the roll. Notice the absence of a shaft. Roll is moved in between lifting arms which are then lowered and closed under pressure and then elevated to unwinding position.

LANGSTON SHAFTLESS UNWIND STAND

Boost your production . . . reduce your slitting and rewinding costs



Easy, fast, completely safe. One man does everything. Operating pushbutton controls, he closes lifting arms, elevates roll, sets brakes.

One man can load the heaviest roll. No heav shaft to handle. No cone tightening. No coupling to engage. No crane lifting. Just pushbuttons. This is the Langston shaftless unwind stand fo rewinding and converting applications.

You not only save time, you also get bette unwinding. Roll can be positioned laterally b pushbutton control—even when the machine i running. It's held firmly under pressure for com plete safety throughout the unwind. Severa braking arrangements can be provided to handl a wide range of grades and conditions. Availabl extras provide for handling very narrow rolls for constant tensioning; for automatic brakin of idler rolls; for automatic web alignment an side register control; for web oscillation; and fo local or remote control.

This new Langston shaftless unwind stand can b used with any make of slitter. Available for maxi mum roll widths up to 140 in. and diameters t 84 in. For complete information, write Samue M. Langston Co., Camden 4, N. J.

Langston *LEADERSHIP . . . BY DESIG*

the invasion has begun!

At this moment . . . there are literally dozens of places where trouble-makers like *Proteus vulgaris* and his army of cohorts are invading paper mills . . . silently . . . quickly . . . raising havoc with a variety of mill operations and affecting finished product quality.

Fortunately, such "invasions" are being repelled successfully in paper mills everywhere through the use of an effectively planned program of microbiological control . . . *ONE* of the many services offered by Betz Laboratories. Through a *specialized* consulting engineering service to the paper industry, Betz offers a wide variety of slime control agents, pitch dispersers, anti-scaling agents, retention aids, filming amines, corrosion inhibitors, and deinker aids.

Data on the *successful* Betz approach to microbiological control in pulp and paper mills is contained in Bulletin 592. May we send you a copy?

Betz Laboratories, Inc., Philadelphia 24, Pa.
Betz Laboratories Ltd., Lachine (Montreal), Canada

BETZ

CONSULTANTS ON MICROBIOLOGICAL CONTROL

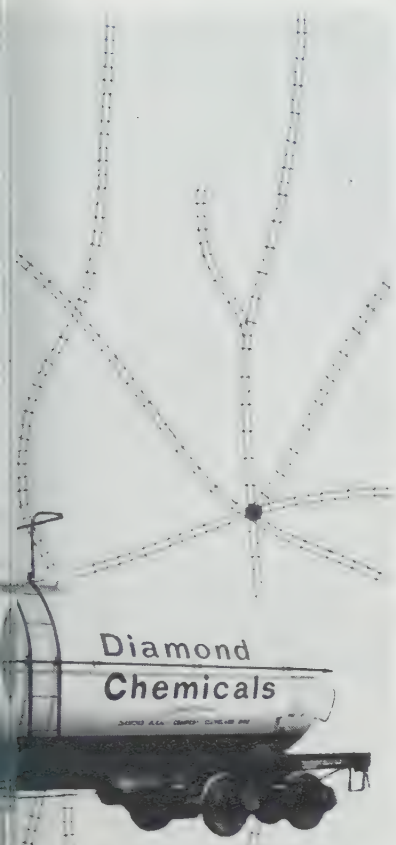
Diamond spent $millions to cu

where the inland waterway goes

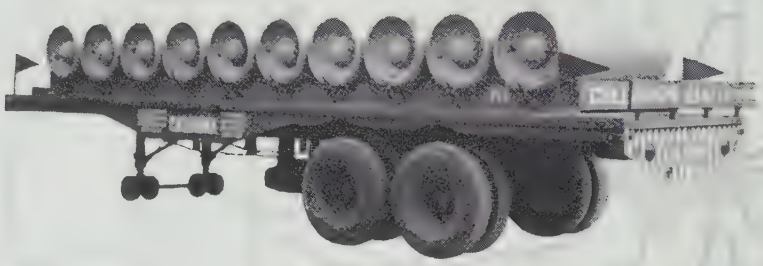
wherever

Diamond delivers liquid chlorine safely from four strategically located plants, regularly to fit in with your production schedules and uniformly to assure you quality every time ■ DIAMOND has invested millions of dollars in "packages" ranging from 100- and 150-lb. cylinders . . . to 15 one-ton containers clamped on special flatcars . . . ton containers on special hi-way trailers . . . to tank cars . . . to 600-ton barges.

your delivered chlorine costs



ailroad goes



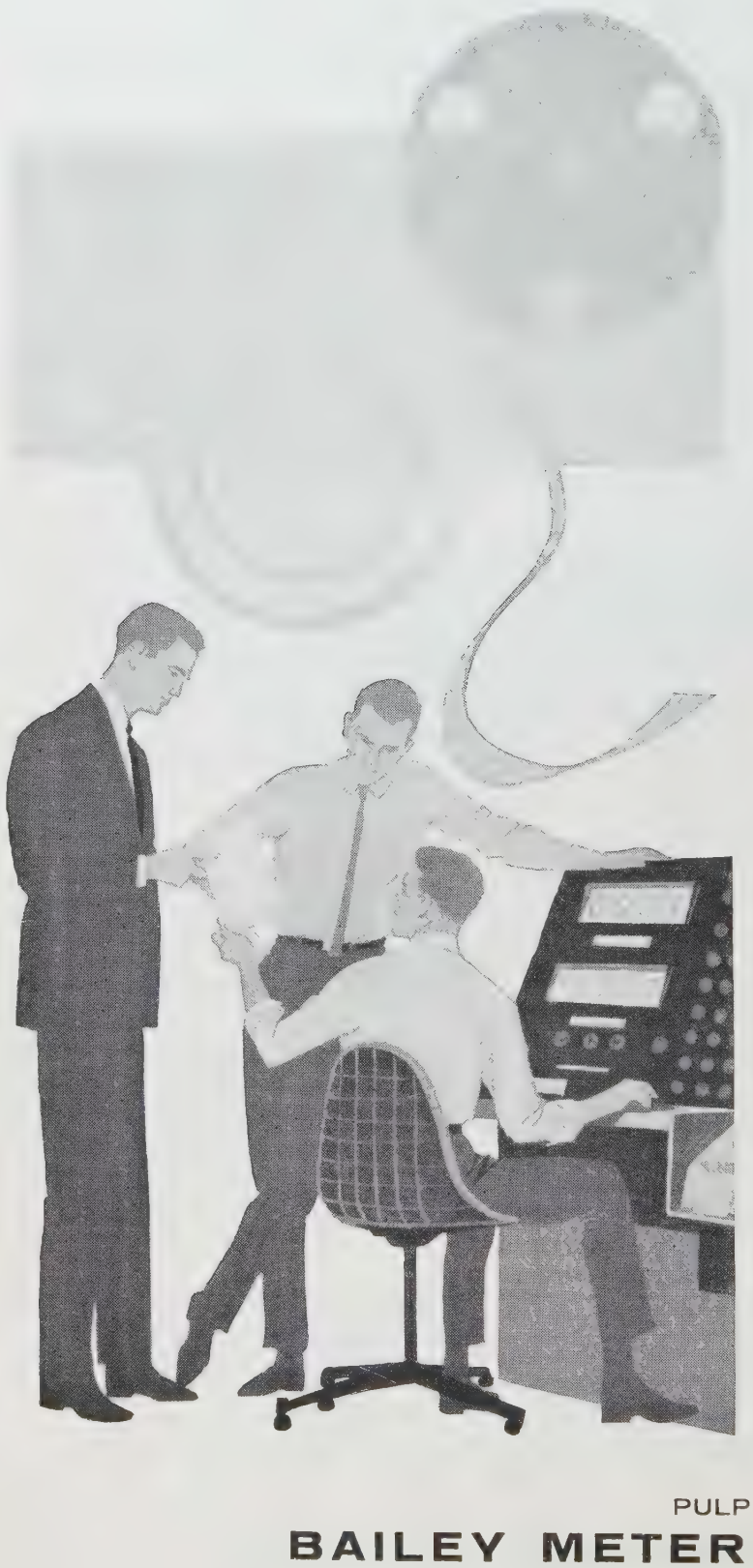
wherever a
truck can go

■ DIAMOND backs up its customer's delivery service with a highly trained technical staff to answer your questions, advise you on liquid chlorine handling and economical use, and help you set up the most economical shipping schedules. For DIAMOND's Chlorine Handbook and a fully illustrated Chlorine Wall Chart, write DIAMOND ALKALI COMPANY, 300 UNION COMMERCE BUILDING, CLEVELAND 13, OHIO.

Diamond Chemicals

HOW FAR . . . AND HOW FAST . . .

can you use computer control *profitably?*



BAILEY 700 SYSTEMS CAN HELP YO DETERMINE THIS—ONE STEP AT A TIM

Can computer control be used—profitabl —in your process operations?

Where and how?

The answer often lies in intermediat stages of improvement in sensing, measu ing, controlling, computing.

Bailey engineers can help you determi and prove — one step at a time — how fa analog or digital systems can be profitabl applied in your operations. Bailey equipped, by broad experience, to provic single-source responsibility from sensi and measuring instrumentation to com plete automation. *Bailey 700 Systems* a installed, in operation, or on order, at loc tions from coast to coast and throughou the world.

Find out what this Bailey background ca offer. Contact your Bailey District Offic

SIX STEPS TO FULL AUTOMATIO

Centralize and simplify information display use analog and digital techniques to clarify infc mation, aid operator understanding, impro reliability of interpretation, and save space.

Extend use of interlocks and limiting circuitry use digital solid-state components to extend supe visory controls, thereby minimizing effects human error.

Increase use of automatic sub-loops—simpli and standardize the starting, controlling, and sto ping of major plant components and sub-system

Extend on-line controls—integrate sub-loop interlocks, and limiting controls with convention controls to secure automatic operation over f range, once unit is on the line.

Provide performance monitoring—add computi facilities to provide significant up-to-date calcul tions for operation improvement and maintenan scheduling.

Integrate all system elements—add start-st control to provide full automation, the ultimate goa

P 158-1

PULP AND PAPER DIVISION

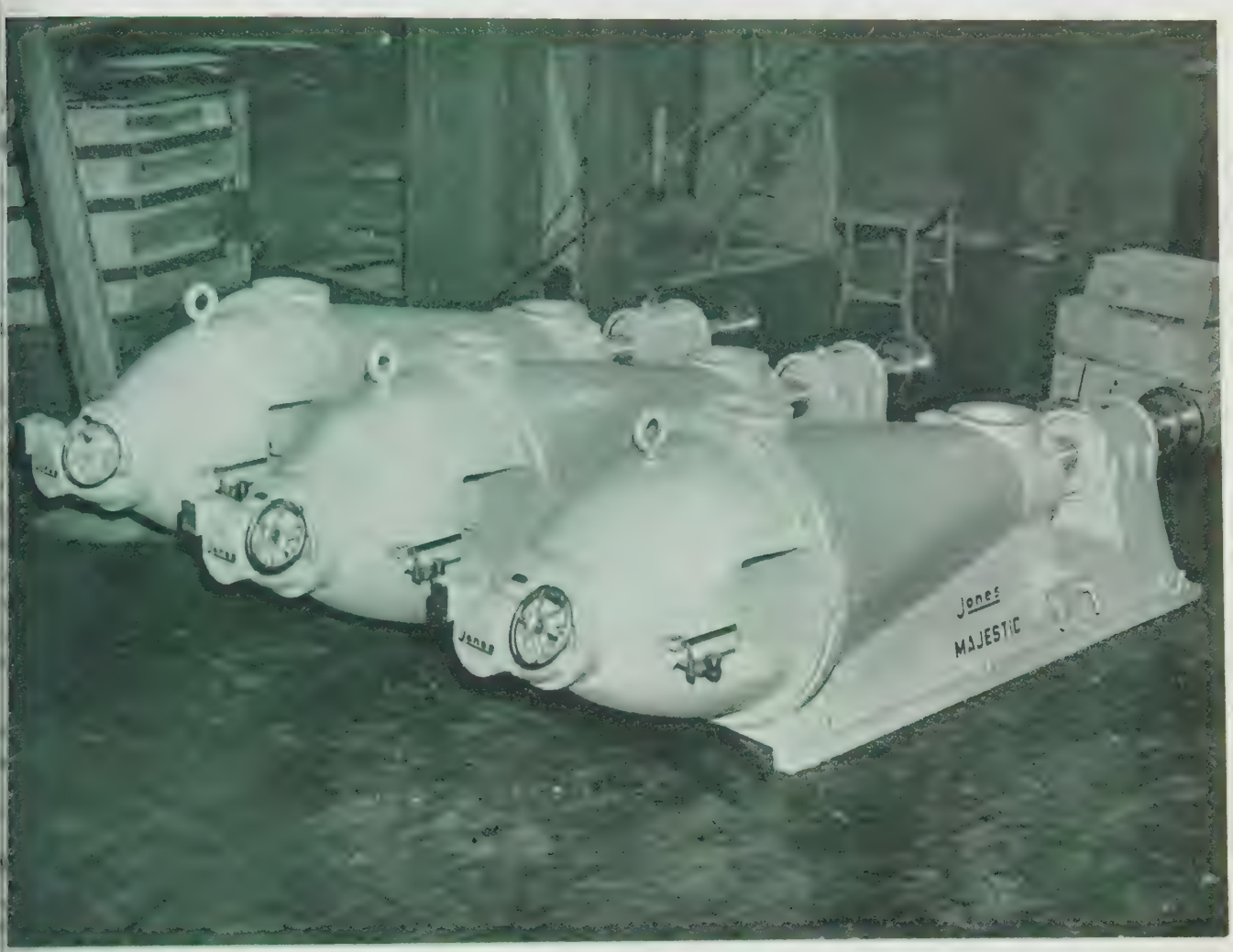
BAILEY METER COMPANY

1077 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

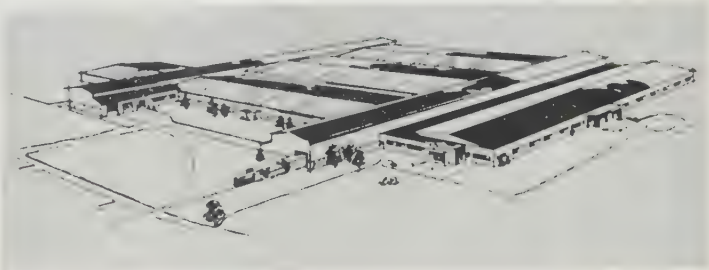
BAILEY METERS

New Jones Majestics



. . precision built in our new plant for the world's newest mills

ome things *are* old about these Jones Majestics . . quality refining results, efficiency of operation nd ease of maintenance, for example. But otherise practically everything else is *new* . . . like ne simplified unit shell construction, the baseounted scale to indicate plug position, the imroved design of bearings, packing glands and ccruset adjusting mechanism. They're the first achines off the production line in Jones' new ittsfield plant . . . and first choice of the world's ewest and finest mills. For full details write to . D. Jones Corporation, Pittsfield, Mass. Ask or Bulletin EDJ-1036.



New Jones Plant in Pittsfield is one of the largest pre-fabricated steel buildings in the country. In it are incorporated the very latest production methods and facilities to assure Jones' continued leadership in the field of pulp mill equipment and stock preparation machinery.

Canadian Associates:
The Alexander Fleck Ltd.
75 Spencer St., Ottawa

E. D. JONES CORP. member BELOIT group PITTSFIELD, MASS.

Jones

PULP MILL EQUIPMENT AND
STOCK PREPARATION MACHINERY

How a groundwood mill screens knots and slivers automatically with the

DORRCO® BAR SCREEN

At Consolidated Paper Corporation, Grand'Mere Quebec, removal of long wood slivers and knots from raw groundwood stock was previously accomplished by a combination of screening through a bar rack and manual raking.

The job is now done automatically and with considerable saving in overhead costs by the unique equipment shown in the photograph. It consists of a bar screen shaped to form a quadrant and continuously cleaned of screened material by a revolving rake mechanism. This unit is installed in a channel 5′6″ wide and 3′ deep. It handles approximately 9,000 gpm of 1% consistency groundwood stock. Screenings comprise about 15 cu. ft. per million gallons.

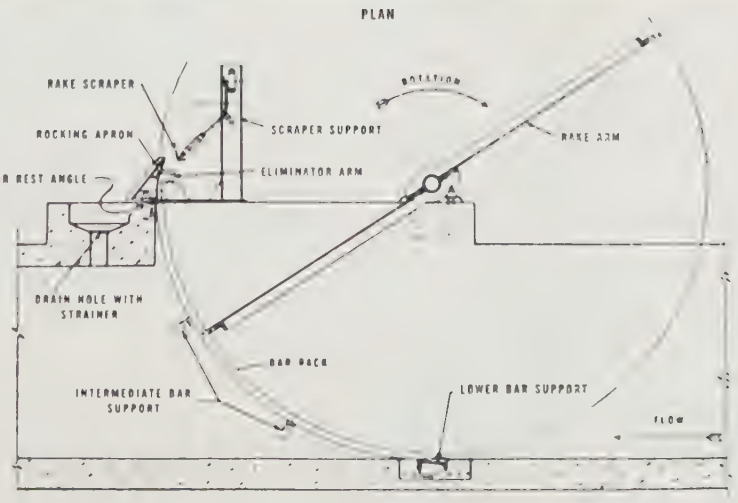
The Dorrco Bar Screen was originally produced for sewage and waste screening. Several hundreds of successful installations for this purpose are in operation. The equipment is simple, rugged and requires little power. A variety of sizes are available and in many cases can be fitted into existing channels. The Consolidated Paper Corporation installation represents the first adaptation of the unit, which was modified and strengthened for use in the pulp and paper field. Opportunities exist for wider application.

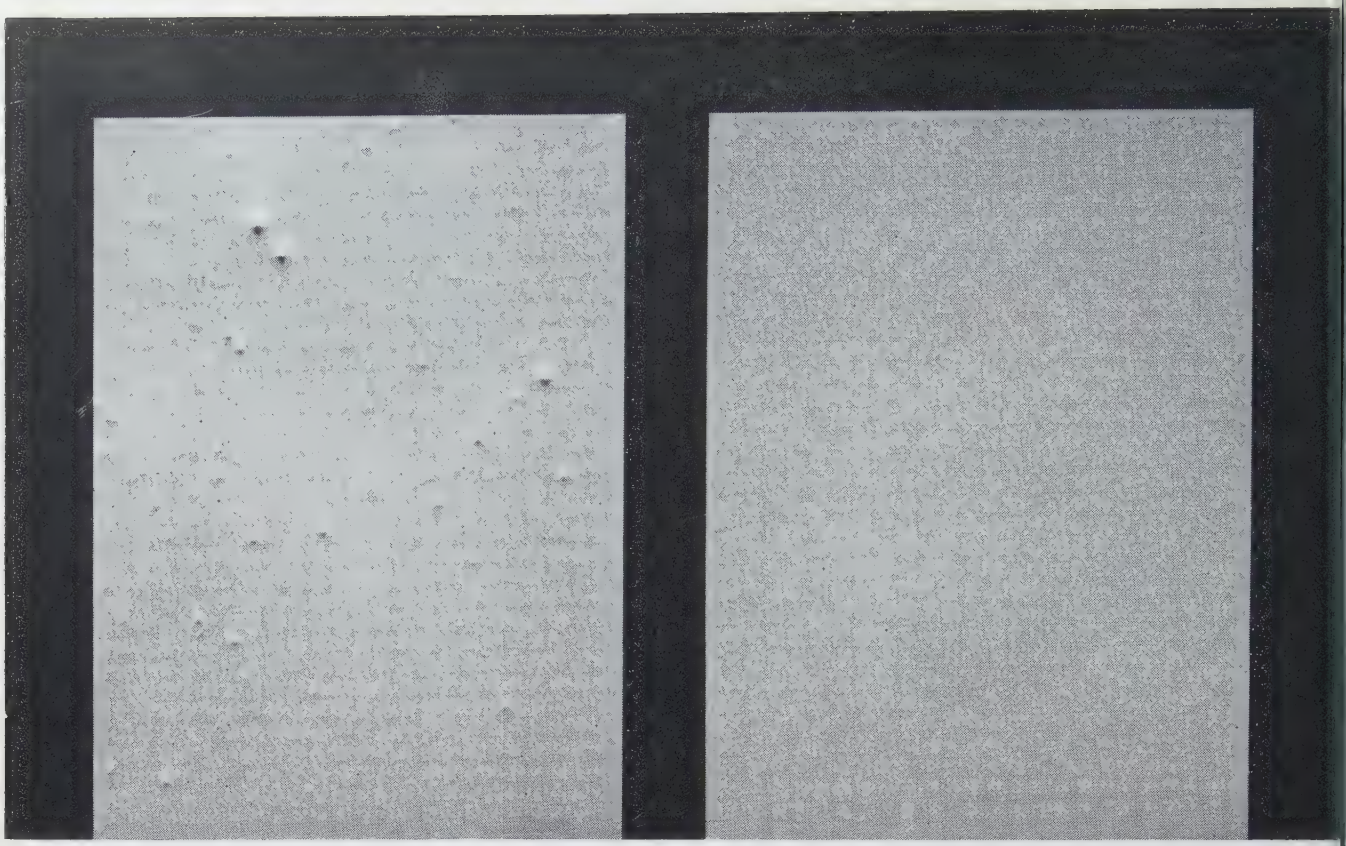
For full information, write to Dorr-Oliver Incorporated, Stamford, Conn.

DORR-OLIVER

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

Operation of the Dorrco Bar Screen is demonstrated in the photograph and the drawing at right. Flow is against the concave side of the screen. Plates at the ends of the revolving rake are toothed to dovetail into the bar openings, preventing any possibility of clogging. Screenings are continuously swept upward and then removed from the rakes by a scraper bar attached to a rocker arm.





Film of 60% solids dispersion
General Purpose Titanium Dioxide
13X magnification

Film of 60% solids dispersion
TITANOX-A-CG
13X magnification

The right "specs." mean NO SPECKS in paper coatings

Your specifications ("specs.") for coatings can well include TITANOX-A-CG, the Coating Grade anatase titanium dioxide pigment.

Made expressly for paper coatings, this pigment is controlled by rigid specifications that maintain not only whitening, brightening and opacifying power, but also the ease of fine dispersion and the freedom from coarse agglomerates that help banish specks.

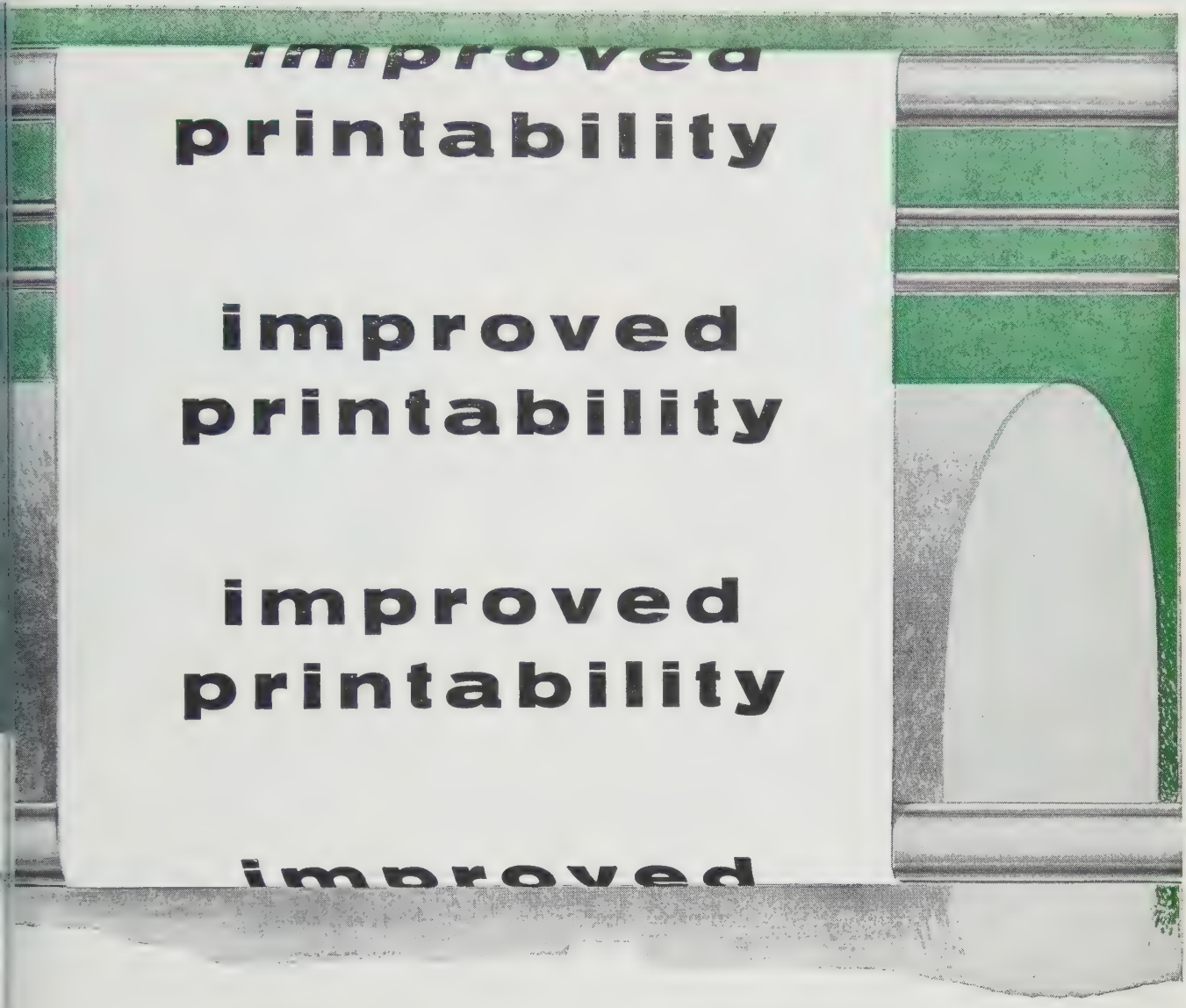
For your coatings that must be produced and used with the utmost speed and still yield surfaces of uninterrupted smoothness, let TITANOX-A-CG be your choice in titanium dioxide.

Titanium Pigment Corporation, 111 Broadway, New York 6, N. Y.; offices and warehouses in principal cities. In Canada: Canadian Titanium Pigments, Ltd., Montreal.

8315

TITANIUM PIGMENT CORPORATION
SUBSIDIARY OF NATIONAL LEAD COMPANY

TITANOX



with Gelva C-3 and C-5 copolymer resins

When used as a surface size, GELVA C-3 and C-5 polyvinyl acetate copolymer resins impart a smooth finish to paper. Ink receptivity is improved. Contrast is sharply defined. When deposited from ammoniacal solution, the resin produces a water resistant film. Used in the size tub or size press, GELVA copolymer resins give improvements in wet and dry tensile and Mullen. The resins are alkali soluble. Broke recovery is quick and easy.

Write for full technical information on GELVA C-3 and C-5. Shawinigan Resins Corporation, Department C, Springfield 1, Massachusetts.

SALES OFFICES: ATLANTA CHICAGO LOS ANGELES NEW YORK CLEVELAND SAN FRANCISCO GREENSBORO SPRINGFIELD ST. LOUIS

PROPERTIES

Form—Fine beads (0.2—1.0 mm. diameter)
Transparency—Excellent
Light Stability—Good
Storage Stability—Excellent

	Softening Point	Maximum Flowable Solution
C-5V-10	123°C	20%
C-3V-10	123°C	35%
C-5V-16	134°C	20%
C-3V-20	155°C	25%
C-3V-30	180°C	20%

Softening Point: Ball and Ring Method
Solution: Ammoniacal

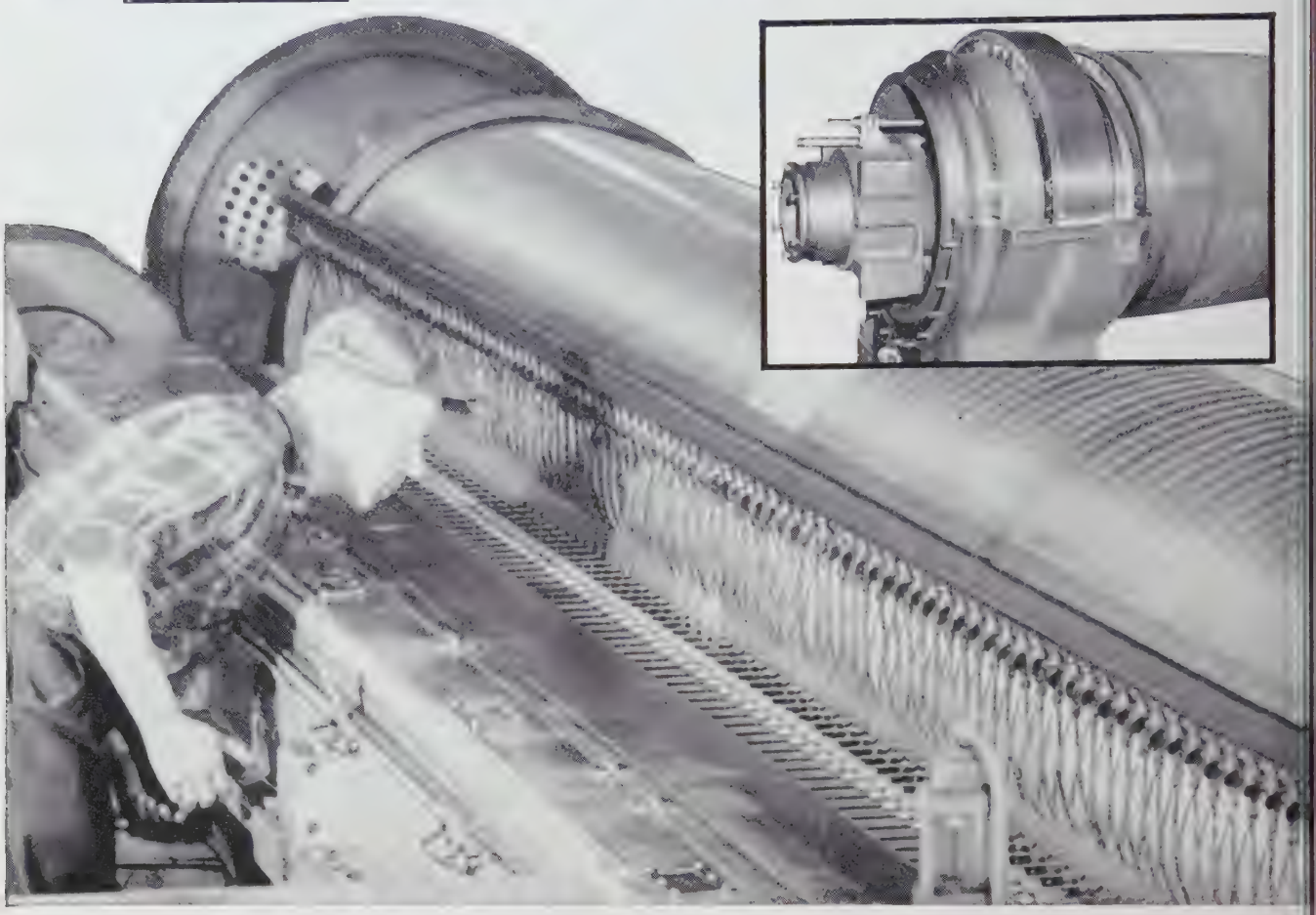
GELVA® *polyvinyl acetate resins by*

SHAWINIGAN RESINS

61-743

Over 100 installations in Canada prove:

MORE EFFICIENT WATER REMOVAL and LONGER FELT LIFE with DOMINION STAINLESS STEEL SUCTION PRESS ROLLS



This proven operating superiority of Dominion rolls is the result of these design and construction features:

DESIGN

★ Open-end design for maximum accessibility and easy inspection.

★ Air-loaded suction box tops to ensure uniform wear of deckles and minimum adjustment.

★ Silent drilling pattern for quieter operation.

CONSTRUCTION

★ Forged stainless steel shell for maximum strength, to permit higher line pressures and ensure longer felt life.

★ Suction connection located either front or rear; easy removal of suction boxes without removing head.

★ Large anti-friction bearings for long life, low maintenance.

★ Adjustable suction box widths.

Dominion Suction Couch Rolls offer all the features listed here. They are normally supplied with a centrifugally cast bronze shell; in certain cases, stainless steel is used to overcome corrosion problems.

FOR FULL DETAILS, PLEASE CONTACT
PAPER DIVISION
DOMINION ENGINEERING
COMPANY LIMITED
Montreal
Toronto
Vancouver

the most complete line of laminating starches and dextrines to meet any operating conditions, investigate...

GLOBE®
starches and dextrines
FOXHEAD®
starches

WRITE OR PHONE *Corn Products for expert technical assistance... helpful data on these fine products for Paperboard Manufacturers:*
CORAGUM® · CORAGUM® FD · GLOBE® and FOXHEAD® starches · GLOBE® and GLOBE® LAM-O-DEX® dextrines

CORN PRODUCTS COMPANY INDUSTRIAL DIVISION • 10 East 56 Street, New York 22, N. Y.

SPRAY DRYERS

. . . for the **best** in paper coating clays

First to spray-dry paper coating clays, MINERALS & CHEMICALS PHILIPP now provides twice the number of spray-drying units of any other coating clay producer.

This is the most precise method used today for drying paper coating clays. Drying is instantaneous, forms microspheroids of clay with a controlled moisture content that can be set as low as ½ of one percent. All four MCP spray dryers are completely instrumented. To the paper maker this means pure, quality-controlled clays of high bulk density, excellent handling properties, and ease of dispersion and make-down. MCP's fourth spray-drying unit offers even greater flexibility to provide a broad range of coating clays to meet individual customer needs.

We will be glad to show you what MCP Edgar spray-dried paper coating clays can do for your products. Write, or give us a call.

Edgar

EDGAR PAPER CLAYS from

MINERALS & CHEMICALS PHILIPP
CORPORATION

2231 ESSEX TURNPIKE MENLO PARK, NEW JERSEY

The Manufacture of Welded Stainless Steel Tubing for Maximum Corrosion Resistance in Kraft Evaporators

S. E. DOUGHTY and W. J. COMERFORD

A review of the use of stainless steel tubing in kraft evaporator service is presented, along with an evaluation of the factors which cause failure of this particular material when exposed to the corrosive environments encountered. Investigation showed that the majority of difficulties could be traced to the cleaning solutions which are used to remove the carbonaceous deposits which build up during the operation of the evaporators. In certain cases these corrosive cleaning agents caused preferential attack on the weld area of Type 304 stainless steel evaporator tubes. The purpose of the study was to determine the reason for this attack and how it occurred, so that corrective measures could be taken. To determine how variations in the manufacturing process of stainless steel tubing could affect its suitability for kraft evaporator service various inspection methods were developed. The most satisfactory screening method developed is to subject the tube to a preferential weld-attack test by immersing samples of the tubing in boiling 50% soln. of HCl for a specified period of time. This test has been used for several years and no failures have been reported on tubing screened by this method.

THIS paper discusses the manufacture and use of welded stainless steel tubing for use in kraft evaporator service. Originally, black liquor evaporators used in the kraft process utilized carbon steel exclusively as a material of construction. However, because of the corrosive action of the black liquor, premature failure of the tubing occurred in the first and second effects, where the steam temperature is at its maximum. In the initial attempts to solve this problem, and thereby extend equipment life, several low alloy steels were employed. None of these materials performed satisfactorily since they did not have the necessary corrosion resistance to withstand destructive attack from the hot liquor. Therefore, after considerable experimentation, Type 304 welded stainless steel tubing (ASTM-A-249 compn: 8–11% Ni, 18–20% Cr, 0.08% C max.) was tested in the more corrosive sections of the evaporator. Except for the infrequent failures which have occurred in the weld area this alloy has solved the corrosion problem and has been employed for over 20 years in the first, and very often the second, effect of black liquor evaporators used in the kraft process.

In the following paragraphs the author will describe the cause of preferential weld attack in Type 304 stainless steel and explain how this type of "in service" failure can be eliminated.

CORROSIVE EFFECTS ON TUBING CAUSED BY PROCESS AND CLEANING

An important economic factor in the sulfate or kraft process is the recovery of spent black liquor from the cooking process. This liquid contains up to 98% of the total alkali charged to the digester, the remainder is usually lost in the washing system. The most common method used to recover the valuable raw materials which are charged to the digester is to concentrate the black liquor in a multiple-effect evaporator. Additional liquid is then removed in a disk or cascade evaporator until it is concentrated to the point where the liquor will ignite and burn when sprayed into a furnace. The liquor recovered from the digester varies from mill-to-mill. However, as stated previously, it contains most of the alkali which is charged to the digester. The alkali is present as sodium carbonate, or as organic sodium compounds with chemical properties similar to sodium carbonate. The liquor also contains the greater part of organic matter recovered from the wood in the cooking process. This organic matter is combined with sodium hydroxide, or forms the sodium salts of resinous and other organic acids. In the sulfate process, organic sulfur compounds are also present in association with sodium sulfide.

The black liquor, which initially contains 15 to 22% solids at temperatures of 160 to 200°F., is passed through the multiple-effect evaporator where water is removed until the black liquor is concentrated to about 50% solid matter. Fresh steam at approximately 287°F. is employed as a heat source in the first effect. Subsequent effects, which operate at a lower shell side pressure, use the vapor which is removed from the previous effect for heating. During the evaporation process the inside diameter of the tubes become fouled with inorganic scale and organic carbonaceous deposits. The outside of the tubing is also subjected to attack by sulfur compounds and distillates, which boil off during the concentration process. These compounds react with the shell side of the steel tubes to form iron sulfide scale. In addition to this attack on the outside surface, the inner surface of the tubing in the first two effects is subjected to attack from sodium sulfide, organic sulfide, sulfonic acid derivatives and other organic acids present in the discharge from the digester.

Cleaning Methods Employed

In an attempt to improve evaporator operations various equipment revisions are being developed which will help reduce this scale buildup on the tube surfaces. However, in equipment that has been installed in existing manufacturing facilities it is necessary to remove these objectional deposits by cleaning the units in one way or another. Water-soluble deposits can be removed by boiling out the units with water, a weak alkali solution, or passing white liquor through them. In general the white liquor wash is followed by a

S. E. DOUGHTY, Manager of Technical Services, W. J. COMERFORD, Manager, Product Engineering & Development, The Carpenter Steel Co., Alloy Tube Division, Union, N. J.

phosphoric acid rinse for neutralization and removal of additional iron sulfide scale. The periodic washings will remove most of the scale but they will not remove the insoluble-carbonte scales which form on the inner surface of the tubing.

Whereas frequent washing will keep evaporators at a fairly efficient level of operation, eventually a hard deposit insoluble in water or white liquor will line the tubing. In order to remove this film most mills have found it necessary to clean the tubes with inhibited hydrochloric acid in concentrations of approximately 5 to 10% to restore evaporators to their original operating efficiency. To enable the hydrochloric acid to do a satisfactory cleaning job it must be heated to a temperature of approximately 170°F. This can be accomplished by preheating the acid and circulating it through the equipment, or allowing the hot acid to stand in the equipment until scale is removed from the inner surface of the tubing. It is also possible to pump cold acids through the evaporator while steam is passing over the outside surface of the tubes to provide the required heat. In some mills the acid is allowed to stand in the equipment while the steam passing through the shell side of the unit serves as a heat source.

Welded Type 304 stainless steel tubing which is used in the first and second effect of most evaporators withstands the corrosive attack of the process liquor very effectively. However, this particular alloy is subjected to localized corrosion from the hydrochloric acid which is used for cleaning purposes. In some cases this attack is more pronounced in the weld area of the tubing than the parent metal. Since the corrosive effect of any acid is dependent on the temperature of the metal, one way to reduce the problem would be to heat the cleaning acid prior to pumping it into the evaporator. In this way the metal temperature of the tubing would be approximately the same temperature as the heated acid. When steam on the outer surface of the tubing is used to heat the acid the metal temperature would be approximately that of the high-temperature steam which is used as the heat source and, therefore, the corrosion rate would increase.

Another way of obtaining better service life from Type 304 stainless steel evaporator tubes is to specify welded stainless steel tubing that is specifically manufactured to withstand the type of attack encountered during evaporator-cleaning operations.

Representative Illustrations

Figure 1 shows the inside surface, which includes the weld area, of a typical, Type 304 stainless steel, pulp mill evaporator tube prior to being installed in service. In the majority of cases austenitic stainless steel will perform satisfactorily in black liquor evaporator service. Figure 2 shows Type 304 stainless steel tubing that has seen several years of use in this type of application. The sectioned specimen on the left shows the heavy carbonate deposit that is formed on the inside surface of typical, black liquor evaporator tubes. The section of tube on the right has been cleaned in the laboratory with a mixture of nitric and hydrofluoric acids, to remove the scale. Close examination of this specimen reveals a slight amount of deposit that could not be removed without damaging the tube. It also shows shallow pits which are distributed throughout the parent metal and weld area of the inside surface of the tubing. This attack is caused by the hydrochloric acid solution employed during equipment cleaning operations. While this corrosion is not desirable, tubing which has performed as well as that shown in Fig. 2 would be acceptable to plant operating personnel. However, there have been scattered cases where welded, Type 304 stainless steel, pulp mill evaporator tubes have failed because of excessive corrosion in the weld area. As was mentioned before, this corrosion is due to the cleaning methods employed and not to the corrosive effect of the blackliquor.

Fig. 1. Section of a full finished Type 304 tube prior to installation

Figure 3 shows tubing which exhibits preferential weld attack from the environment encountered in pulp mill evaporator service. The specimen on the left is uncleaned except for a small area which was mechanically scraped in an attempt to remove the carbonate deposit. The piece of tubing on the right has been cleaned chemically. The parent metal shows a slight amount of pit-type corrosion; however, in this sample the weld area is severely attacked. In another part of this same tube the area containing the weld was completely corroded. To inspect the weld area which has been attacked extensively a section of the tube which contains the weld metal has been prepared for metallurgical examination and is shown in Fig. 4. This figure also clearly illustrates the extent that the weld area has corroded.

Fig. 2. Cleaned and uncleaned sample of satisfactory Type 304 kraft evaporator tubing

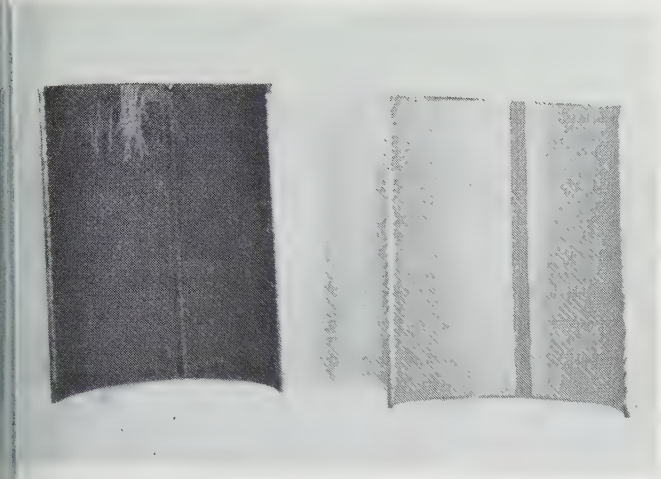


Fig. 3. Cleaned and uncleaned sample of unsatisfactory, Type 304 kraft evaporator tubing

Metallurgical Properties of Weld

To explain why one length of Type 304 tubing performs satisfactorily while another tube of the same composition fails in an equivalent service it is necessary to review what happens during the welding of a piece of stainless steel tubing. At the point of welding there is under the arc a small pool of liquid metal in which the alloying elements are uniformly distributed. After passing under the arc this pool freezes extremely rapidly. The freezing and subsequent cooling to room temperature is so rapid that the resulting solid metal at room temperature is nonuniform both in chemical composition and in crystal structure. This structure is illustrated in Fig. 5. This figure shows the pools of ferrite in a basis matrix of austenite dendrites. In addition to these obvious variations in crystal structure it is known that the principal alloying elements, chromium and nickel are not uniformly distributed throughout the structure.

These differences in composition and crystal structure will cause differences in corrosion resistance in various areas of the weld. The magnitude of these differences in corrosion resistance will vary with the corrosive medium to which the structure is exposed. It has been found by experiment that these differences

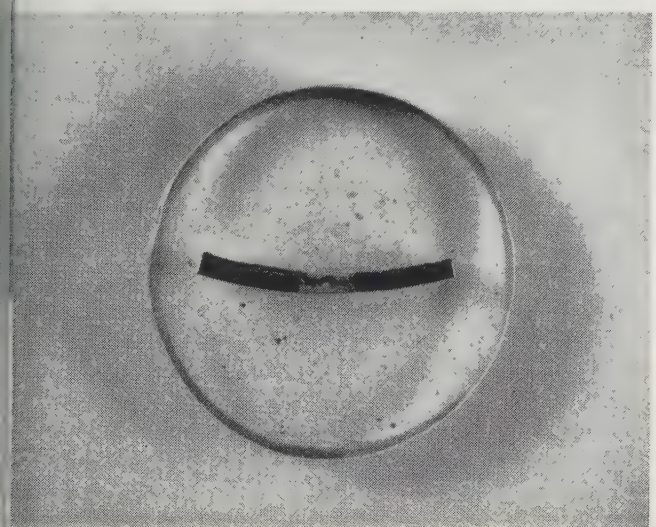


Fig. 4. Section of tube showing extent of corrosion in weld area

Fig. 5. Section through weld area of as-welded Type 304 tubing. Magnification approx. 500×

in corrosion resistance in a hydrochloric acid solution are large, and that the differences are in the direction of rapid attack of the semicontinuous pools of ferrite and the areas adjacent to them. Tubing in the as-welded condition contains more or less continuous pools of ferrite. Therefore, it is possible for the corrosion to proceed from one pool to another, attacking the material to a considerable depth in these particular areas (cf. Fig. 3). A photomicrograph of the weld area of this sample is shown in Fig. 6. Close inspection of the photomicrograph reveals semicontinuous pools of ferrite in the microstructure of the Type 304

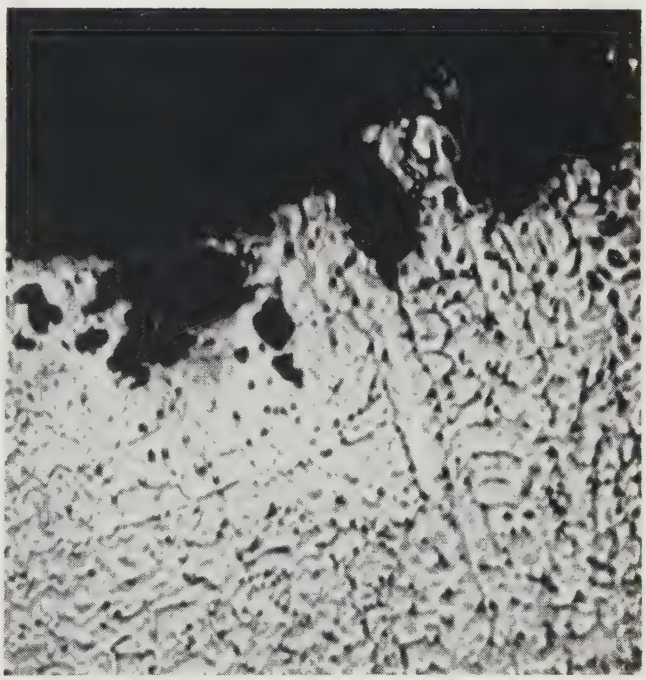


Fig. 6. Weld area of Type 304 evaporator tubing which exhibited preferential weld attack. Magnification approx. 500×

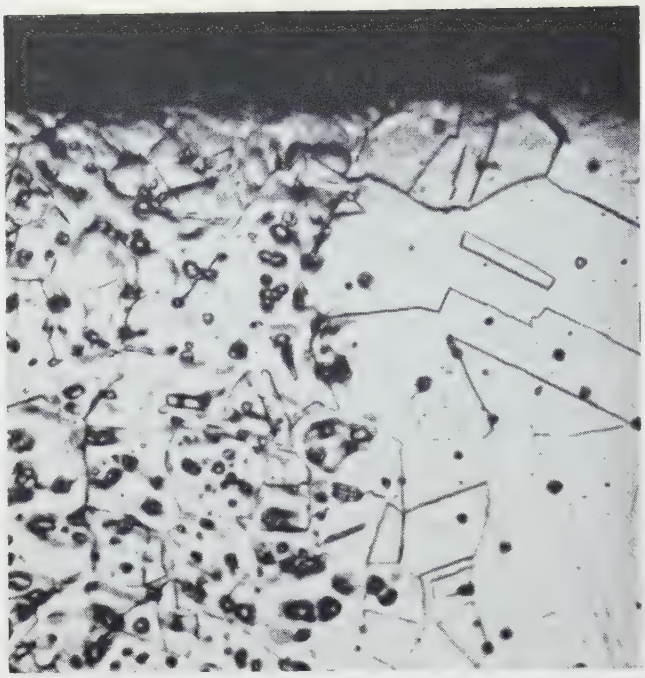


Fig. 7. Weld parent metal interface of Type 304 tubing which does not exhibit preferential weld attack. Magnification approx. 500×

stainless steel weld metal. In fact it is possible to observe several areas of the exposed surface where these pools of ferrite were preferentially attacked by the corrosive used to clean the tubing.

To compare the metallurgical structure of material which performed satisfactorily in service and that which failed a photomicrograph (Fig. 7) was made of the weld parent metal interface of the acceptable tubing shown in Fig. 2. Figure 7 reveals that the semi-continuous dendritic structure, which is common to the as-welded material previously shown, has been broken up and that there is no measurable preferential attack on either the parent metal or in the weld area.

MANUFACTURING WELDED STAINLESS STEEL TUBING

Procedures

The difference in the microstructure, and consequently the corrosion resistance of tubing which performed satisfactorily in service and that which failed, is due primarily to the process used to manufacture the product. Practically all welded, stainless steel, pulp mill evaporator tubes utilize coils of Type 304 strip as raw material. In the simplest process this strip is welded, straightened, possibly tested for leaks, inspected, and shipped. The microstructure of the weld area of tubing produced in this manner will be similar to the unsatisfactory material shown in Fig. 5 or 6.

An improvement in the quality of the product can be obtained by annealing the tubing after the welding operation. Holding the tubing at a temperature of approximately 2050°F. during annealing permits migration of the atoms of chromium and nickel so that more uniform chemical composition is obtained within the crystals and the high-temperature ferrite phase is dissolved. However, to enable welded Type 304 stainless steel to perform satisfactorily in pulp mill evaporator service and to resist the corrosive action of the strong cleaning solutions employed, it is desirable to break up the dendritic structure in the weld area as a further aid to producing a metallurgically and chemically uniform structure. While solution heat-treating will help to accomplish this, the best method of obtaining a satisfactory product is to produce tubing using a process which employs a combination of cold working and annealing.

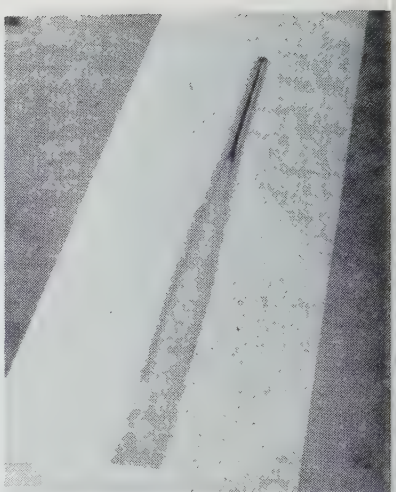


Fig. 8. Forming stages used to produce welded tubing in a continuous mill

An accepted manufacturing procedure would consist of gradually forming the stainless-steel strip into a tubular shape by passing it through a series of rolls until it is completely round and ready for welding. Figure 8 shows the forming stages used to accomplish this. From the final forming rolls, the tubing passes into the welding section of the tube mill. Here the longitudinal butted edges are continuously fused together by an inert gas–shielded arc welding process. This is done without the use of flux or adding filler metal. Therefore, the weld area will have the same overall composition as the parent metal. Inert gas is used to prevent oxidization of the weld or the parent metal during the welding operation.

After the welding operation is completed the tubing is cold-worked. This cold working helps to break up the dendritic structure which was formed when the molten metal solidified during the welding operation. Annealing at a temperature of 2050°F. then improves the corrosion resistance of the tubing by helping to dissolve the ferrite in the weld area. This annealing also relieves stresses built up during the forming and cold-working operations. After annealing, the material is machine-straightened and pickled in a mixture of nitric and hydrofluoric acids so that the finished tube will have a clean, smooth inside and outside surface. Pickling not only removes annealing scale but also passivates the tubing by forming a passive film on the surface so that it will have maximum corrosion resistance in service.

Infection Methods

After the manufacturing process is completed, welded tubing, and in particular that which is to be used for kraft evaporator service, receives an extensive inspection. The material must pass a rigid air or hydrostatic test, or both, to determine if it contains any leaks. In addition to close visual inspection eddy current, nondestructive testing is also utilized. The latter critically checks outside and inside surfaces, subsurface conditions, thickness, and chemistry over the entire length and periphery of the tubing. As a final control, destructive tests, such as crush, flattening,

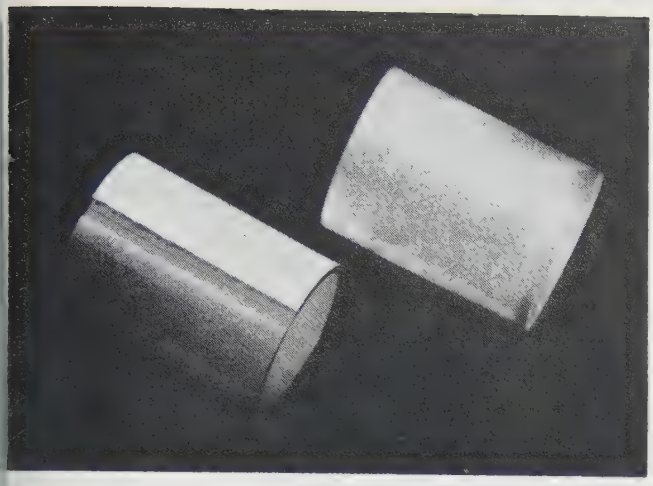


Fig. 9. Material exposed to preferential weld attack test

flare, flange, and tensile tests are conducted on a sample basis.

Inspection methods just discussed and the proper manufacturing tubing for pulp mill evaporator service go a long way toward assuring the user of obtaining adequate service life from the material. However, the only way to be certain of obtaining proper performance is to have the material installed and tested under actual mill operating conditions. Since this type of material evaluation and testing is impossible because of the time and cost factors involved a laboratory test procedure has been developed which adequately determines whether or not Type 304 welded stainless steel tubing will perform satisfactorily in black liquor evaporator service.

This test consists of immersing sections of tubing containing the weld area in a boiling solution (50% by volume) of commercially concentrated hydrochloric acid. The test samples are left in this boiling solution until the parent metal wall dimension is reduced by 50%, or 2 hr. have elapsed. The tubing is then removed from the acid, cleaned, and examined for any indication of preferential attack in the weld area. This test environment is much more severe than the 5 to 10% hydrochloric acid cleaning solution used and therefore provides an adequate method of screening tubing. The tubular sections shown in Fig. 9 were subject to the above test. Examination of the specimen on the left shows that the weld area was corroded away considerably more than the parent metal. This particular tube would have failed the test and is not considered satisfactory for kraft evaporator service. The sample on the right was exposed to the same environment and, as can be seen, the corrosion is uniform throughout the parent metal and weld area.

A photomicrograph of the weld parent metal interface of the tube which suffered preferential weld attack is shown in Fig. 9. The microstructure of the weld area clearly illustrates the extent of destruction discussed previously. The corrosive attack can also be seen progressing through the ferrite on the surface of the tubing where it was exposed to the boiling hydrochloric acid. Since the ferrite in this specimen is rather continuous it is possible for the corrosive to eventually eat through the entire wall of the tube. This tubing was produced without an adequate combination of annealing and cold working, and probably would not be satisfactory in serivce. However, the

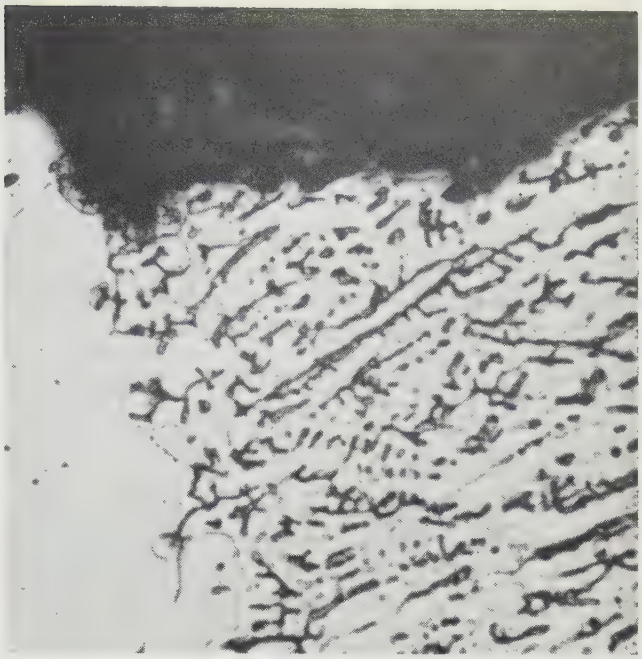


Fig. 10. Weld parent metal interface of Type 304 material which failed preferential weld attack test. Magnification approx. 500×

tube shown on the right in Fig. 9 was processed in the proper manner and has the ferrite in the weld structure sufficiently dissolved and crystal structure reoriented so that the corrosive could not find a path of ferrite through the material. An example of the metallurgical structure of the weld area and parent metal of such a tube is shown in Fig. 7. While a certain amount of ferrite is still present in the weld area it has been broken up and dissolved to an extent which makes it resistant to attack.

CONCLUSIONS

As a result of information received from users and producers of welded, Type 304 stainless steel, kraft evaporator tubes, it is apparent that this particular alloy in welded tubular form is a satisfactory material of construction for the first and second effects of most black liquor evaporators.

The problems encountered with this material have been relatively few and only one type has been serious enough to cause any concern. The major difficulty, which is caused by cleaning solutions used to remove carbonate deposits from the inside tubing wall, could be corrected by revising the cleaning procedures or using tubing which is processed in a manner that will reduce the preferential attack that has occurred in the weld area. Since it is not possible or practical to revise the cleaning procedures at the present time it will be necessary for the ultimate customer to specify material which will satisfactorily resist the corrosive effect of the present day cleaning solutions. This can be best accomplished by stating that the material is to be used for pulp mill evaporator service and ordering it to the proper ASTM Specification, such as A-249. In addition to this we strongly recommend that the formal order contain a requirement that the material satisfactorily pass the preferential weld attack test mentioned previously in this report.

RECEIVED Feb. 28, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N.Y., Feb. 20–23, 1961.

Report of TAPPI Flat Crush Study

COMMITTEE ASSIGNMENT NO. 689

The effect of five different variables on the flat crush test was studied. This work was sponsored by the TAPPI Flat Crush Subcommittee of the Container Testing Committee in order to develop data for standardizing the instruments and test procedure for this test. The results show that a flat crush test procedure should specify that the crush tester show no lateral platen movement, that platen speed and rate of loading should be held within certain limits, and that sample size and shape can be selected on the basis of ease or convenience.

In 1957 the Container Testing Committee decided that a study should be made of variables involved in flat crush testing of corrugated board. A flat crush subcommittee was set up to handle this work and an experiment was designed which would give the answers desired by the committee.

The variables examined were the following:

A. The effect of loading speed on the test result.
B. The effect of type of loading as represented by various machines; such as, the Hinde & Dauch, National Forge, and others.
C. The effect of sample size on flat crush test values.
D. The effect of sample shape on flat crush test value per square inch.
E. The effect of lateral movement.

The project was submitted to several laboratories, following which the Committee decided that Container Laboratories, Inc., would do the work. In addition to the tests done by Container Laboratories, Inc., the committee felt that tests should be run on a third type of crush tester. Mr. Maltenfort of Container Corp. of America advised that they were working on such a machine and would be glad to make it available for this study. The committee accordingly instructed Container Laboratories to turn over to Mr. Maltenfort such remaining samples available after Container Laboratories' portion had been concluded.

DESIGN OF EQUIPMENT

Materials Tested

Twelve sheets each of 200 lb. test double faced A, B and C-flute corrugated board, size 52 1/2 by 73 1/8 in., made with fourdrinier kraft liners and semichemical medium, were procured from a single source. Average test results of these materials were as follows:

	A-flute	*B-flute*	*C-flute*
Liners:			
Caliper, in.	0.013	0.013	0.013
Basis weight, lb./MSF	43.7	42.4	41.3
Medium:			
Caliper, in.	0.009	0.009	0.009
Basis weight, lb./MSF	27.8	27.0	27.6
Combined board: Caliper, in.	0.203	0.126	0.166

This report was supported by TAPPI Grant No. 133 and reflects the efforts of the members of the Committee, especially those of H. G. Nelson, Owens-Illinois Glass Co., Toledo, Ohio, and G. G. Maltenfort, Container Corp. of America, Chicago, Ill., who devoted much time in development and preparation.

Sample Preparation

Prior to marking, cutting and testing, the corrugated sheets were placed in a preconditioning atmosphere of 30% R.H. and 90°F. for a period of 6 hr. They then were placed in a "standard testing atmosphere" of 50% R.H. and 73°F. for not less than 24 hr prior to the testing of the specimens.

Each full sheet was marked off into 204, 4 1/8 by 4 1/8 in. squares, allowing a margin for waste at each of the four edges. A total of 2448 sample squares were obtained from the 12 sheets for each flute, or a total of 7344 samples squares for the 36 sheets of all three flutes. The twleve sheets of each flute were identified with letters A through L and the squares were numbered as follows:

A-1	204	G-1225	1426
B-205	408	H-1429	1632
C-409	612	I-1633	1836
D-613	816	J-1837	2040
E-817	1020	K-2041	2244
F-1021	1224	L-2245	2448

An example of a sheet layout is shown in Table I.

The full sheets were then cut into 7344 individual 4-in square pieces. (A precision power saw was employed for this purpose.) The samples for each flute were then selected by means of "Random Numbering Tables" obtained from "Statistical Tables for Biological, Agricultural and Medical Research," by R. A. Fisher and F. Yates (Oliver and Boyd, 1948). The randomized samples were then distributed in 30 groups numbered 1 through 30, in quantities of 75 squares per group. Twenty-five samples from each of the 30 groups were recut to size and shape required for these tests.

Container Laboratories' square specimens were cut on a precision power saw, CCA's square samples were cut with a razor blade. Both the 5- and 10-sq. in. samples were cut with the corrugations parallel to one pair of opposite edges. The round specimens were cut by means of a motor-driven, circular specimen cutter at Container Laboratories, with a hand-operated cutter at Container Corp.

The groups were selected for cutting as follows:

Twenty-five samples in each of groups 2, 4, 6, 8, 10, 12, 26, 28, and 30 were recut into 10 sq. in., round specimens.

Twenty-five samples in each of groups 1, 3, 5, 7, 9, 11, 25, 27, and 29 were recut into 5 sq. in., round specimens.

Twenty-five samples in each of groups 20, 22, and 24 were recut into 10 sq. in., square specimens.

Twenty-five samples in each of groups 19, 21, and 23 were recut into 5 sq. in., square specimens.

The 25 samples from each group, as recut above, were used in the current test study.

Twenty-five samples in each of groups 14, 16, and 18 were recut into 10 sq. in., round specimens and 25 samples in each of groups 13, 15, and 17 were recut into 5 sq. in., round specimens. All of these samples

Table I. Sheet Layout

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17
A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31	A32	A33	A34
A35	A36	A37	A38	A39	A40	A41	A42	A43	A44	A45	A46	A47	A48	A49	A50	A51
A52	A53	A54	A55	A56	A57	A58	A59	A60	A61	A62	A63	A64	A65	A66	A67	A68
A69	A70	A71	A72	A73	A74	A75	A76	A77	A78	A79	A80	A81	A82	A83	A84	A85
A86	A87	A88	A89	A90	A91	A92	A93	A94	A95	A96	A97	A98	A99	A100	A101	A102
A103	A104	A105	A106	A107	A108	A109	A110	A111	A112	A113	A114	A115	A116	A117	A118	A119
A120	A121	A122	A123	A124	A125	A126	A127	A128	A129	A130	A131	A132	A133	A134	A135	A136
A137	A138	A139	A140	A141	A142	A143	A144	A145	A146	A147	A148	A149	A150	A151	A152	A153
A154	A155	A156	A157	A158	A159	A160	A161	A162	A163	A164	A165	A166	A167	A168	A169	A170
A171	A172	A173	A174	A175	A176	A177	A178	A179	A180	A181	A182	A183	A184	A185	A186	A187
A188	A189	A190	A191	A192	A193	A194	A195	A196	A197	A198	A199	A200	A201	A202	A203	A204

KEY TO ABBREVIATIONS

CL	Container Laboratories
CCA	Container Corp. of America
NF	National Forge & Ordnance Tester
H & D	Hinde & Dauch crush tester
CCT	Concora crush tester
Rd.	Round sample
Sq.	Square sample

were prepared and later sent to Container Corp. for use with their third testing machine.

All remaining specimens were reserved for any necessary duplication of tests.

Types of Testing Instruments

Three types of testing instruments are represented in this study:

The Hinde & Dauch (H&D) Crush Tester. On this instrument the sample is placed on a platen resting on a bending beam, with a driven upper platen applying load.

Container Laboratories used two of these testers for their portion of the study. One was a 500-lb. beam instrument loaned to them for this project by Testing Machines, Inc. The 10-sq. in. B-flute sets exceeded the capacity of this instrument, and for that portion of the study, they used their own 1000-lb. beam H & D crush tester.

Container Corp. also used two H & D's: a 1000- and a 500-lb. beam tester. To balance things out they reversed Container Laboratories' procedure and used the 1000-lb. beam machine on all series except one, and the 500-lb. beam tester on the 5-sq. in. B-flute set.

Only Container Laboratories did the series with three differing loading rates, 15, 25, and 50 lb. per sec. This was accomplished by changing pulley ratios.

The National Forge and Ordnance Tester. On this instrument the lower platen is a weight scale which measures the load applied to the specimen by a driven upper platen. On this machine, the rates of loading can be varied by a speed reducer, which is an integral part of the instrument.

The Concora Crush Tester. This is a newly developed tester for measuring CMT, CLT, and flat crush. The operating principle is opposite to that of the H & D. The lower platen is driven against the specimen, and the load is measured through the upper platen. The upper platen is kept parallel to the lower platen during the test. The data in this study were measured on the prototype. Details will be disclosed later. All machines were checked and calibrated prior to their use for this study.

Lateral Movement of Platens. Tests also were performed in order to measure the differences between flat crush results obtained when the H & D crush tester has lateral movement of platens and when its platens have no lateral movement. The H & D crush tester was modified to cause lateral movement in both the upper and lower platens of the machines. This was accomplished in the lower platen by decreasing the thickness of the pins which held it in place on the beam. Lateral movement was induced in the upper platen by replacing the lower key with a slightly smaller key to allow play in the spindle. Also, the gear box cover, with top key, was removed.

After the H & D tester was modified as explained above, dial indicators were used to measure the amount of lateral movement which had been produced in the lower and upper platens. It was found that a lateral movement of 0.0260 in. was induced in the upper platen in the direction parallel to the bar and 0.0146 in. of lateral movement was measured perpendicular to the bar. For the lower platen, a lateral movement of 0.0300 in. was measured both parallel and perpendicular to the bar.

Performance of Tests

All averages in this study are based on 25 tests. The orientation of the test specimens in the testers was as follows:

Hinde & Dauch	Corrugations parallel to the beam
National Forge	Perpendicular to the front of the machine
Concora crush tester	Corrugations facing operator

Concerning their test data, Container Laboratories states: "All test data recorded on the flat crush failures were based on those samples which had no leaning corrugations and no evidence of slippage, except for those tests performed with lateral movement of the platens, where all tests were included."

On the Container Corp. data, all tests made were accepted since no leaners were observed.

It was originally contemplated that Container Corp. would add only one set of data to this study, the one for the third instrument. Since Container Laboratories was good enough to send three additional sets, it was decided to add one additional factor to this study, missing in the original design: a replication on the same instrument. It is always instructive to include in any instrument comparison at least one instance of running a duplicate (replication) set on the same machine. In this study every set on the Concora crush tester was run twice for the round samples.

Analysis of the Data

An experiment such as this, which involved comparisons of a large number of averages and variances, presents some special problems in data analysis. Sep-

arating the data according to the classifications embodied in the experimental design (testers, sample area, platen speed, etc.) and running the usual analysis of variance, "F" and "t" tests usually results in complete confusion, because significant differences arise in one portion of the data to be contradicted by some other portion of the data representing the same treatment. There are ample reasons for this, but we cannot discuss them here. Suffice it to say that there are two techniques available for handling problems of this kind, which deserve to be known better. One technique is known as the "gap" test on means (*1*) and the other is Cochran's test on the homogeneity of variances (*2*).

Tables II to VII show the entire body of data obtained in this study. In every case no average or group of averages were spearated by the gap test to be significantly different from the rest.

On Cochran's test for the homogeneity of variances we find the following:

A. On the 10-sq. in. area, A-flute series, the variances for the Concora crush test—square cut samples and one (but not the other) of the Concora crush test—round samples was excessive.

B. On the 10-sq. in. B-flute data, one (but not the replicate) of the Concora crush test round samples had an excessive variance.

C. In all the remaining series, none of the instruments had an excessive variance. There is therefore no

Table II. A-flute, 10-sq. in. Area
$n = 25$

No.	*Lab.*	*Tester*	*Loading rate, lb./sec.*	*Platen speed, in./min.*	*Sample shape*	*Av. lbs./10 sq. in.*	*Variance, σ^2*	ΣX
1	CL	NF	15	...	Rd.	345	246.20	8632
2	CCA	CCT	167	1.0	Sq.	350	1104.76	8738
3	CL	NF	25	...	Rd.	351	240.96	8785
4	CL	NF	50	...	Rd.	358	283.71	8951
5	CL	H & D	15	0.9	Sq.	359	662.33	8984
6	CL	H & D	15	0.9	Rd.	361	425.85	9013
7	CL	H & D	25	1.5	Sq.	361	455.72	9031
8	CL	H & D	25	1.5	Rd.	362	447.75	9061
9	CCA	CCT	167	1.0	Rd.	368	596.42	9211
10	CL	H & D	50	3.0	Rd.	369	218.71	9218
11	CL	H & D	50	3.0	Sq.	370	355.71	9244
12	CCA	CCT	167	1.0	Rd.	378	1098.78	9453
13	CCA	H & D	33	1.0	Rd.	387	727.83	9673
				Average		363		
				Σ:			6864.74	117,994
	$\Sigma X^2 = 43,040,164$			$(\Sigma X)^2/N = 42,878,381$				

Table III. B-flute, 10-sq. in. Area
$n = 25$

No.	*Lab.*	*Tester*	*Loading rate, lb./sec.*	*Platen speed, in./min.*	*Sample shape*	*Av. lb./10 sq. in.*	*Variance, σ^2*	ΣX
1	CL	NF	15	...	Rd.	518	426.33	12,941
2	CL	H & D[a]	15	0.9	Sq.	529	492.88	13,213
3	CL	NF	25	...	Rd.	535	640.88	13,372
4	CL	H & D[a]	25	1.5	Sq.	536	480.50	13,391
5	CL	H & D[a]	50	3.0	Sq.	547	551.40	13,677
6	CL	H & D[a]	15	0.9	Rd.	548	499.75	13,702
7	CL	H & D[a]	25	1.5	Rd.	558	1037.50	13,961
8	CCA	CCT	167	1.0	Rd.	569	1722.26	14,213
9	CL	H & D[a]	50	3.0	Rd.	572	779.83	14,300
10	CL	NF	50	...	Rd.	574	1155.63	14,343
11	CCA	CCT	167	1.0	Sq.	586	653.06	14,658
12	CCA	CCT	167	1.0	Rd.	589	916.62	14,724
				Average		555		
				Σ:			9356.64	166,495
	$\Sigma X^2 = 92,775,295$			$(\Sigma X)^2/N = 92,550,837$				

[a] This is not the same H & D Container Laboratories used throughout the rest of the study, which was a 500-lb. beam tester. The instrument above was Container Laboratories' own 1000-lb. beam machine, used because the capacity of the 500-lb. beam H & D was exceeded by this data.

Table IV. C-flute, 10-sq. in. Area
$n = 25$

No.	*Lab.*	*Tester*	*Loading rate, lbs./sec.*	*Platen speed, in./min.*	*Sample shape*	*Av. lbs./10 sq. in.*	*Variance, σ^2*	ΣX
1	CL	NF	15	...	Rd.	430	480.13	10,746
2	CL	NF	25	...	Rd.	434	547.46	10,843
3	CL	H & D	15	0.9	Sq.	440	372.25	11,005
4	CL	H & D	25	1.5	Sq.	447	148.25	11,175
5	CL	H & D	15	0.9	Rd.	447	219.38	11,178
6	CL	NF	50	...	Rd.	448	465.88	11,196
7	CL	H & D	50	3.0	Sq.	452	312.54	11,304
8	CL	H & D	25	1.5	Rd.	452	513.50	11,309
9	CCA	CCT	167	1.0	Sq.	456	688.79	11,407
10	CCA	H & D	33	1.0	Rd.	459	215.69	11,481
11	CCA	CCT	167	1.0	Rd.	462	430.49	11,541
12	CL	H & D	50	3.0	Rd.	465	535.04	11,631
13	CCA	CCT	167	1.0	Rd.	467	428.19	11,681
				Average		451		
				Σ:			5357.59	146,497
	$\Sigma X^2 = 66,203,119$			$(\Sigma X)^2/N = 66,074,537$				

consistent evidence that any given instrument is more or less variable than the others.

CONCLUSIONS

1. Six different testers comprising three distinct types (National Forge, Hinde and Dauch, and Concora crush tester) were evaluated. All gave comparable test results, both with respect to averages and variability, on all three (A, B, and C) flute constructions.

The largest average deviations from the pooled means turned out as in Table VIII.

To illustrate: The pooled mean for the A-flute 10-sq. in. area was 36.3 p.s.i. The largest average in this series was 38.7 p.s.i., or 2.4 p.s.i. or 6.6%.

2. The commonly used sample area is 10 sq. in.; however, the 5-sq. in. sample is used in laboratories having crush testers with a 500-lb. beam load limit. They convert test values to pounds per square inch by multiplying them by 0.2. This study shows that this is an acceptable procedure, and test results so obtained are equivalent to 10-sq. in. test results (Table IX)

3. The testers in this study had the following rates of loading, lb. per sec., measured with no sample in the tester: 15, 16, 25, 33, 50 and 167. (When a sample is under test, the pounds per second loading rate varies with the test load.) The tests results were unaffected by these loading rate differences. Setting up a ranking sys-

Table V. A-flute, 5-sq. in. Area
$n = 25$

No.	Lab.	Tester	Loading rate, lb./sec.	Platen speed, in./min.	Sample shape	Av. lbs./5 sq. in.	Variance, σ^2	ΣX
1	CL	NF	15	...	Rd.	162	265.13	4,054
2	CL	H & D	15	0.9	Rd.	172	147.00	4,305
3	CL	H & D	25	1.5	Rd.	173	166.04	4,322
4	CL	NF	25	1.5	Rd.	173	259.75	4,336
5	CCA	CCT	167	0.9	Sq.	174	166.67	4,345
6	CL	NF	50	3.0	Rd.	177	84.83	4,435
7	CCA	CCT	167	0.9	Rd.	178	190.81	4,442
8	CCA	CCT	167	0.9	Rd.	178	152.01	4,461
9	CL	H & D	15	0.9	Sq.	180	150.92	4,490
10	CL	H & D	25	1.5	Sq.	183	106.71	4,568
11	CCA	H & D	33	1.0	Rd.	185	222.59	4,636
12	CL	H & D	50	3.0	Sq.	186	56.75	4,659
13	CL	H & D	50	3.0	Rd.	190	87.92	4,760
				Average		178		
				Σ:			2057.13	57,813
	$\Sigma X^2 = 10,350,150$			$(\Sigma X)^2/N = 10,300,470$				

Table VI. B-flute, 5-sq. in. Area
$n = 25$

No.	Lab.	Tester	Loading rate, lb./sec.	Platen speed, in./min.	Sample shape	Av. lb./5 sq. in.	Variance, σ^2	ΣX
1	CCA	H & D	16	1.0	Rd.	255	541.26	6,364
2	CCA	CCT	167	0.9	Rd.	261	481.83	6,525
3	CL	NF	15	...	Rd.	266	182.12	6,657
4	CL	NF	25	...	Rd.	272	221.96	6,807
5	CCA	CCT	167	0.9	Rd.	276	410.49	6,891
6	CL	NF	50	...	Rd.	278	139.63	6,947
7	CL	H & D	15	0.9	Sq.	283	370.92	7,062
8	CL	H & D	15	0.9	Rd.	283	265.42	7,085
9	CL	H & D	25	1.5	Sq.	287	336.46	7,182
10	CL	H & D	25	1.5	Rd.	289	147.00	7,221
11	CCA	CCT	167	0.9	Sq.	290	528.01	7,238
12	CL	H & D	50	3.0	Sq.	293	187.96	7,319
13	CL	H & D	50	3.0	Rd.	295	122.92	7,384
				Average		279		
				Σ:			3935.98	90,682
	$\Sigma X^2 = 25,390,509$			$(\Sigma X)^2/N = 25,349,864$				

Table VII. C-flute, 5-sq. in. Area
$n = 25$

No.	Lab.	Tester	Loading rate, lb./sec.	Platen speed, in./min.	Sample shape	Av. lb./5 sq. in.	Variance, σ^2	ΣX
1	CL	NF	15	...	Rd.	214	63.00	5,360
2	CCA	CCT	167	0.9	Rd.	216	152 01	5,412
3	CCA	CCT	167	0.9	Rd.	217	129.08	5,430
4	CCA	CCT	167	0.9	Sq.	217	85.63	5,432
5	CL	H & D	15	0.9	Rd.	222	88.79	5,543
6	CL	H & D	15	0.9	Sq.	224	83.13	5,596
7	CL	H & D	25	1.5	Sq.	225	113.71	5,631
8	CL	H & D	50	3.0	Sq.	226	88.50	5,640
9	CL	NF	25	...	Rd.	226	171.08	5,640
10	CCA	H & D	33	1.0	Rd.	226	155.46	5,657
11	CL	NF	50	...	Rd.	227	126.25	5,681
12	CL	H & D	25	1.5	Rd.	233	155.13	5,822
13	CL	H & D	50	3.0	Rd.	236	82.08	5,900
				Average		224		
				Σ:			1493.85	72,744
	$\Sigma X^2 = 16,330,228$			$(\Sigma X)^2/N = 16,294,376$				

tem so as to group the data in ascending order of loading rate and treating the shape of the samples as being of no consequence, we can compare the actual rankings with this hypothetical scheme (Table X.) In four out of the six available comparisons, nonsignificant correlation coefficients resulted. This is confirmation by an independent method of the result obtained by the analysis of variance.

4. Similarly, the test results were unaffected by the range of platen speeds used. Several testers having different rates of loading had identical platen speeds, so that the platen speed variable was even more random with respect to the test results than were the rates of loading.

5. In practice, round samples are preferable to square samples because it is not necessary to worry about locating edges so as to insure the same number of load bearing flutes on all specimens, which is time-consuming. Nevertheless, if one does take the time and proper care, square-cut samples will give comparable results to round samples of equal area.

6. It is to be expected, and the experiment confirms, that lateral movement of platens on the H & D type tester is an undesirable condition. The table below shows that for the most part, appreciably lower flat crush tests are obtained, and that an unpredictable but generally high fraction of the tests will show slippage (Table XI).

7. In summary, this experiment may be considered to have two important practical consequences:

A. If proper care is exercised in controlling testing conditions, calibration of instruments and sample sample preparation, we have considerable latitude in our choice of the type of tester, sample area, sample size, and loading rate.

B. Loading rates as divergent as 15 and 167 lb. per sec. achieved comparable test results. This characteristic is therefore not very definitive as a test method specification. Platen speed, on the other hand, was varied only from 0.9 to 3.0 in. per min., a relatively narrow range compared to the loading rates. This suggests that a platen speed of 1.0 to 1.5 in. per min. would suffice to pin down the range within which comparable flat crush tests can be obtained.

Table VIII. Largest Av. Deviation from Pooled Mean

10 sq. in.	A-flute	2.4 p.s.i.—6.6%
	B-flute	3.7 p.s.i.—6.7%
	C-flute	2.1 p.s.i.—4.6%
5 sq. in.	A-flute	3.2 p.s.i.—8.4%
	B-flute	4.0 p.s.i.—7.2%
	C-flute	2.4 p.s.i.—5.4%

Table IX. Comparison of 10 vs. 5 sq. in. Flat Crush, p.s.i.

	Av. 10 sq. in. flat crush	*$\pm 2\sigma^a$ Limits*	*Av. 5 sq. in. flat crush*
A-flute	36.3	0.91	35.6
B-flute	55.5	1.12	55.8
C-flute	45.1	0.81	44.8

[a] σ calculated from the "within" mean square obtained in the analysis of variance.

Table X. Actual vs. Theoretical Rankings of Testers

Tester	*Loading rate, lb./sec.*	*A-flute Theory*	*A-flute Actual*	*B-flute Theory*	*B-flute Actual*	*C-flute Theory*	*C-flute Actual*
		10-sq. in. Area					
NF	15	1	1	1	1	1	1
H & D	15	2	5	2	2	2	3
H & D	15	3	6	3	6	3	5
NF	25	4	3	4	3	4	2
H & D	25	5	7	5	4	5	4
H & D	25	6	8	6	7	6	8
H & D	33	7	13	..	..	7	10
H & D	50	8	4	7	10	8	6
NF	50	9	10	8	5	9	7
H & D	50	10	11	9	9	10	12
CCT	167	11	2	10	8	11	9
CCT	167	12	9	11	11	12	11
CCT	167	13	12	12	12	13	13
Rank correlation coefficient:		+0.528		+0.881		+0.890	
Significant:		No		Yes		Yes	
		5-sq. in. Area					
NF	15	1	1	1	3	1	1
H & D	15	2	2	2	7	2	5
H & D	15	3	9	3	8	3	6
NF	25	4	4	4	1	4	9
H & D	25	5	3	5	4	5	7
H & D	25	6	10	6	9	6	12
H & D	33	7	11	7	10	7	10
NF	50	8	6	8	6	8	11
H & D	50	9	12	9	12	9	8
H & D	50	10	13	10	13	10	13
CCT	167	11	5	11	2	11	2
CCT	167	12	7	12	5	12	3
CCT	167	13	8	13	11	13	4
Rank correlation coefficient:		+0.506		+0.346		+0.0275	
Significant:		No		No		No	

Supplementary Comments

A few supplementary comments should be added:

1. It will be noted that CCA did not duplicate the work done by Container Laboratories. Only Container Laboratories made tests on varying loading rates on the same tester, both on the NF and H & D instruments.

Comparing loading rates on this portion of the data on each instrument separately and on square and round samples separately—so that the only variable is the loading rate—the averages always fall in ascending order as the loading rate increased from 15 to 25 to 50 lb. per sec.

Table XI. Comparison of Test Results with and without Lateral Movement
Averages based on $n = 25$

Test	*Sample, sq. in.*	*Loading rate, lb./sec. 15 A*	*15 B*	*15 C*	*25 A*	*25 B*	*25 C*	*50 A*	*50 B*	*50 C*
Without lateral movement	10 round	36.1	54.8	44.7	36.2	55.8	45.2	36.9	57.2	46.5
Lateral movement	10 round	23.8	41.2	26.9	25.5	39.6	27.7	28.8	40.2	29.3
Number of samples showing slippage		21	25	25	24	25	25	18	25	25
Without lateral movement	5 round	34.4	56.7	44.3	34.6	57.8	46.6	38.1	59.1	47.2
Lateral movement	5 round	34.3	39.2	43.5	33.5	39.7	39.1	33.0	40.8	42.6
Number of samples showing slippage		3	25	8	4	25	12	5	25	4

Table XII. Effect of Rate of Loading

Flute	Machine	Shape	Area sq. in.	Loading rate, lb./sec. 15	25	50	Increase, %, or decrease from 25 lb./sec. 15 lb./sec.	50 lb./sec.
A	H & D	Rd.	10	36.05	36.24	36.87	(0.52)	1.74
			5	34.44	34.58	38.08	(0.40)	10.12
		Sq.	10	35.94	36.12	36.98	(0.49)	2.38
			5	35.92	36.54	37.21	(1.69)	1.97
	NF	Rd.	10	34.53	35.13	35.80	(1.70)	1.90
			5	32.44	34.68	35.48	(6.45)	2.30
Average				34.89	35.55	36.75	(1.85)	3.37
B	H & D	Rd.	10	54.81	55.84	57.20	(1.84)	2.44
			5	56.68	57.76	59.08	(1.86)	2.29
		Sq.	10	52.85	53.56	54.71	(1.33)	2.15
			5	56.50	57.46	58.56	(1.67)	1.91
	NF	Rd.	10	51.76	53.49	57.37	(3.23)	7.25
			5	53.26	54.46	55.58	(2.20)	2.06
Average				54.31	55.43	57.08	(2.02)	2.98
C	H & D	Rd.	10	44.71	45.24	46.52	(1.17)	2.83
			5	44.34	46.58	47.20	(4.81)	1.33
		Sq.	10	44.02	44.70	45.22	(1.52)	1.16
			5	44.76	45.04	45.12	(0.62)	0.18
	NF	Rd.	10	42.98	43.37	44.78	(0.90)	3.25
			5	42.88	45.12	45.44	(4.96)	0.71
Average				43.95	45.01	45.71	(2.36)	1.56

Table XIII. Comparison of Testing Machines

Flute	Shape	Area, sq. in.	Loading rate, lb./sec.	H & D machine	NF machine	Increase %, or decrease from H & D
A	Rd.	10	15	36.05	34.53	(4.20)
			25	36.24	35.13	(3.16)
			50	36.87	35.80	(2.90)
		5	15	34.44	32.44	(5.81)
			25	34.58	34.68	0.29
			50	38.08	35.48	(6.83)
Average				36.04	34.68	(3.77)
B	Rd.	10	15	54.81	51.76	(5.56)
			25	55.84	53.49	(4.21)
			50	57.20	57.37	0.30
		5	10	56.68	53.26	(6.03)
			25	57.76	54.46	(5.71)
			50	59.08	55.58	(5.92)
Average				56.90	54.32	(4.53)
C	Rd.	10	15	44.71	42.98	(3.87)
			25	45.24	43.37	(4.13)
			50	46.52	44.78	(3.74)
		5	10	44.34	42.88	(3.29)
			25	46.58	45.12	(3.13)
			50	47.20	45.44	(3.73)
Average				45.77	44.09	(3.67)

Table XIV. Comparison of Specimen Shape

Flute	Machine	Area, sq. in.	Loading rate, lb./sec.	Round	Square	Increase %, or decrease from round
A	H & D	10	15	36.05	35.94	(0.30)
			25	36.24	36.12	(0.33)
			50	36.87	36.98	0.29
		5	15	34.44	35.92	4.29
			25	34.58	36.54	5.67
			50	38.08	37.21	(2.28)
Average				36.04	36.45	1.13
B	H & D	10	15	54.81	52.85	(3.71)
			25	55.84	53.56	(4.08)
			50	57.20	54.71	(4.35)
		5	15	56.68	56.50	(0.32)
			25	57.76	57.46	(0.52)
			50	59.08	58.56	(0.88)
Average				56.90	55.61	(2.26)
C	H & D	10	15	44.71	44.02	(1.54)
			25	45.24	44.70	(1.19)
			50	46.52	45.22	(2.79)
		5	15	44.34	44.76	0.95
			25	46.58	45.04	(3.31)
			50	47.20	45.12	(4.41)
Average				45.77	44.81	(2.09)

It is true that the consolidated analysis of variance (Tables II to VII, CCA report below) showed that within each table all differences between averages were non-significant, and that in many cases the differences in the ranked loading rate results above are small indeed. Nevertheless, the fact that these rankings were so consistent and occurred on both instruments, should not be overlooked.

2. A comparison of the H & D and NF machine discloses that in the majority of cases, Container Laboratories' H & D tested higher than their NF tester, with two minor exceptions. It would be difficult to say whether this could be expected to be generally true or merely reflects a situation existing between these two particular testers. If we add CCA's H & D to the comparison, we get the following from Tables II to VII of the CCA report:

Table II—CCA's H & D, 33-lb. per sec. loading rate tested *higher* than CL's H & D with a 50-lb. per sec. loading rate

Table IV—Same as Table I

Table V—CCA's H & D, 33-lb. per sec. loading rate tested *lower* than CL's H & D with a 50-lb. per sec. loading rate

Table VI—CCA's H & D, 16-lb. per sec. loading rate (not the same H & D as in Tables II, IV, and V) tested *lower* than CL's H & D with a 15-lb. per sec. loading rate

Table VII—CCA's H & D with a 33-lb. per sec. loading rate tested *lower* than CL's H & D at the 25 and the 50-lb. per sec. loading rate.

A fair summary of this situation is that the data of this study are not adequate to prove either that the National Forge tester is consistently comparable or consistently different from the H & D tester. To sustain such a proof would require a comparison between several instruments of each type, an experiment not envisioned in this study.

LITERATURE CITED

1. Tuckey, J. W., *Biometrics* 5, No. 2: 99–114 (June, 1949).
2. Eisenhart C., Hastay M. H., and Wallis W. H., "Techniques of Statistical Analysis," pp. 388–394, New York, McGraw-Hill, 1947.

RECEIVED June 22, 1961.

Brightness of High Yield Pulps

III. Further Studies in Bleaching With Sodium Borohydride

PHILIP LUNER and ROBERT SUPKA

From previous results of bleaching white birch cold-soda pulp with sodium borohydride the brightness increment obtained was plotted as a function of the sodium borohydride consumed. For the same chemical consumption smaller brightness increments were obtained at lower bleaching temperatures. The quantitative consumption of sodium borohydride under milder conditions (pH 9.2 and room temperature) was determined for eight wood species. The carbonyl content ranged from 0.1 to 0.5 mmole/g. of wood. The distribution of the carbonyl groups in the extracted wood, extractives, lignin, and carbohydrates varied widely. The sodium borohydride consumption for unextracted white birch wood meal was 0.334 mole/g. of wood: alcohol-benzene, extracted 0.195 mmole/g. and 0.228 mmole/g. for extraction with 0.15*N* NaOH. The higher sodium borohydride consumption (0.53 mmole/g.) during bleaching of the cold-soda pulp is ascribed to the alkali degradation of the polysaccharides, which form carbonyl groups, and to the greater accessibility of carbonyl groups in the noncarbohydrate components at higher temperatures and pH. Pre-reduction of white birch and spruce wood meal decreased the alkali extractability by 15 and 2%, respectively, while the corresponding holocellulose preparation when prereduced with sodium borohydride decreased the alkali extractability 30 to 53%, respectively. Treatment of white birch wood meal with sodium hydrosulfite, sodium bisulfite, diazomethane, alkaline peroxide, and hypochlorite reduced the carbonyl content up to 80%, depending on the treatment.

MAYER AND DONOFRIO (*1*) studied the bleaching effect of sodium borohydride on a softwood groundwood pulp (65% red spruce, 35% balsam fir). Using a maximum of 2% sodium borohydride and consistencies ranging from 2.5 to 10%, a maximum of 10 points brightness increase was found at 35°C. Under unbuffered conditions (35°C. and 1% sodium borohydride, 2.5% consistency) a 7.8 brightness increment was found corresponding to a consumption of 25% of the applied chemical. More recently, Luner (*2*) using white birch cold-soda pulp found that larger brightness increments could be obtained, if the sodium borohydride were stabilized with 0.1*N* NaOH and higher bleaching temperatures were used (50 to 100°C.). While the brightness increments gained by the two pulps may not be directly comparable, owing to differences in the type and accessibility of coloring material, it was of interest to determine the true chemical consumption during the reductive bleaching of white birch cold-soda pulp. With this data a more realistic estimate of bleaching costs can be made.

At low temperatures sodium borohydride is chemically consumed in the reduction of aldehydic end groups in cellulose and hemicellulose, and the reduction of carbonyl groups in lignin and extractives. At high temperatures secondary reactions in alkaline medium, involving a peeling reaction from the aldehydic chain ends also occur. In addition, new carbonyl groups may become accessible at elevated temperatures leading to higher consumptions of sodium borohydride. It was therefore of added interest to determine the sodium borohydride consumption of white birch and its components at lower temperatures and pH, and to compare these results with those obtained in bleaching at higher temperatures.

CHEMICAL CONSUMPTION DURING SODIUM BOROHYDRIDE BLEACHING

The sodium borohydride consumed at 75 and 50°C. in 0.1*N* NaOH with 1% sodium borohydride (on the weight of the pulp) at 3, 10, and 15% consistencies was determined by subtracting the amount due to decomposition from the total chemical consumed during bleaching. This was accomplished by first establishing decomposition curves for sodium borohydride solutions in 0.1*N* NaOH at the appropriate concentration and temperature. These results are shown in Table I. Figure 1 relates the brightness increment to the chemical consumed for these and other miscellaneous experiments which are plotted for comparative purposes.

First, it may be noted that in alkaline solution, using a single stage bleach, 0.5 to 0.6% sodium borohydride is consumed with 1% applied sodium borohydride. However, an additional 0.5% is consumed if a second 1% stage is applied under the same conditions. A brightness increment is also associated with this additional consumption, as seen in Fig. 1. This result is similar to the one found when successive amounts of sodium borohydride are added to white birch cold soda under unbuffered conditions (*2*) and illustrates how accessibility influences bleaching. While brightness increases with chemical consumption, part of this consumption, as will be shown later, is due to reactions other than those producing brightness increments.

Figure 1 also shows that sodium borohydride consumed at 25°C., either in 0.1*N* NaOH or unbuffered, is not as efficient in producing brightness increments as that consumed at 50 and 75°C. This result again may be interpreted in terms of accessibility. At higher temperatures, diffusion and reaction rates facilitate reduction (and perhaps extraction) more uniformly *throughout* the cell wall whereas at lower temperatures reduction may occur more on *the surface* of the cell material. The difference in consumption values between the data for spruce and white birch may, however, be due more to differences in the type of lignin and surface characteristics of the pulp than to temperature effects.

PHILIP LUNER, Assistant Professor of Pulp and Paper Research, and ROBERT SUPKA, Technical Assistant, Empire State Paper Research Institute. State University College of Forestry at Syracuse University Syracuse 10, New York.

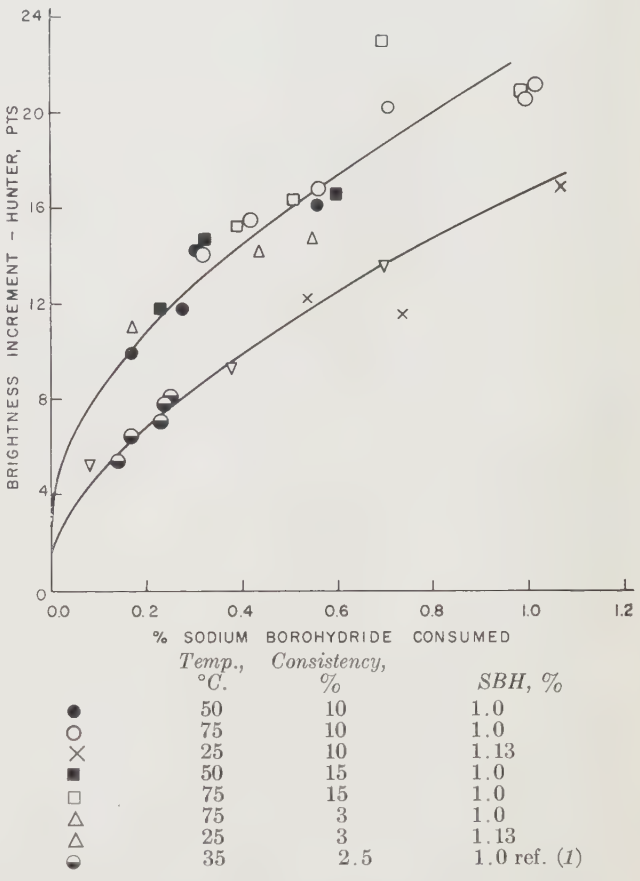
Throughout this investigation it was noted that differences in initial brightness, refining characteristics, and chemical consumption were found between pulps of the same wood species. One of the major reasons for these differences was the proportion of heartwood. These results, therefore, should be regarded as indicative of trends rather than as absolute values.

DISTRIBUTION OF CARBONYL GROUPS IN VARIOUS WOOD SPECIES

Thus far, the sodium borohydride consumed during bleaching has been determined under alkaline conditions and at elevated temperatures. Since secondary reactions consuming sodium borohydride might be occurring, it seemed logical to determine the sodium borohydride consumption under conditions where secondary reactions are at a minimum. The amount of sodium borohydride consumed at pH 9.2 by the sample was determined using a volumetric method previously described (*22*). Wood meal, 40–60 mesh, was used instead of fibers to eliminate as much as possible physical inaccessibility and to increase the reaction rate. In addition to determining the carbonyl content of white birch it seemed of further interest to extend this study to a variety of hardwood species and to the different wood components such as the extractives, holocellulose, and lignin. These results, given in Table II, were obtained by determining the carbonyl content on the unextracted wood, alcohol-benzene extracted wood, and on the corresponding holocellulose preparations. The partition of the carbonyl groups between the holocellulose and lignin may, therefore, depend to some extent on the preparation. In fact, a calculation of the carbonyl groups in the lignin of sprucewood in Table II gives a value of 0.13 mmole per g. of wood, whereas for native spruce lignin and milled-wood spruce lignin values ranging between 0.5 and 2 mmole per g. of wood have been obtained (*3*, *4*). A value of 0.286 mmole per g. of wood of carbonyl group was obtained for a fractionated spruce lignin sulfonic acid and 0.42 mmole per g. of wood for spruce periodate lignin. It can be seen further that the total carbonyl content varies widely between species and does not correlate with the per cent extractives. For white birch heartwood, 64% of the carbonyl groups are in the extractives. If the composition of the wood is taken into account (70% sapwood; 30% heartwood: total carbonyl 0.334 mmole per g. of wood), approximately 50% of the total carbonyl is in the heartwood component and 30% of the total in the heartwood extractives alone. The relatively low carbonyl content in the extractives of red oak and the high carbonyl content in black gum indicates differences in chemical structure of these extractives.

Table I. Sodium Borohydride (SBH) Bleaching of White Birch Cold Soda
1% SBH, 0.1*N* NaOH

Conditions	Time, hr.	Hunter brightness, %	SBH consumed, % wt. of pulp	Brightness increment, points
15% Consistency, 50°C.	0	44.4	...	...
	1.0	56.2	0.23	11.8
	2.0	59.0	0.33	14.6
	4.0	61.0	0.60	16.6
15% Consistency, 75°C.	0	46.6	...	...
	2.0	61.8	0.39	15.2
	3.75	62.9	0.51	16.3
Second stage	0	62.9	...	...
	2.0	67.6	0.19	23.0
	4.0	67.3	0.48	20.7
10% Consistency, 50°C.	0	44.4	...	...
	1.0	54.3	0.17	9.9
	2.0	56.2	0.28	11.8
	4.0	58.6	0.31	14.2
	7.0	60.5	0.56	16.1
10% Consistency, 75°C.	0	46.6	...	...
	2.0	60.6	0.32	14.0
	4.0	62.1	0.42	15.5
	6.0	63.3	0.56	16.7
Second stage	0	63.8	...	...
	2.0	65.6	...	...
	4.0	66.7	0.15	20.1
	6.0	67.2	0.44	20.6
	7.0	67.8	0.46	21.2
10% Consistency, 25°C.	0	46.8	...	...
	24	58.3	0.74	11.5
	0	46.6	...	...
	24	59.1	0.54	12.6
	48	63.5	1.06	16.9
3% Consistency, 25°C.	0	46.8	...	...
	1.0	52.0	0.08	5.2
	4.5	56.1	0.38	9.3
	24.0	60.4	0.71	13.6
3% Consistency, 75°C.	0	44.9	...	...
	1.0	53.1	...	...
	2.0	55.9	0.17	11.0
	4.0	59.1	0.44	14.2
	6.0	59.5	0.55	14.6



	Temp., °C.	Consistency, %	SBH, %
●	50	10	1.0
○	75	10	1.0
×	25	10	1.13
■	50	15	1.0
□	75	15	1.0
△	75	3	1.0
△	25	3	1.13
◒	35	2.5	1.0 ref. (*1*)

Fig. 1. The relationship between sodium borohydride (SBH) consumed and brightness increments under various conditions

The effect of alkali extraction on the carbonyl content of white birch wood meal was investigated next and these data are tabulated in Table III. The carbonyl content of the alkali-extracted wood meal (heartwood and sapwood) is then 0.228 mmole per g. of wood for the 0.15*N* alkali extraction and 0.179 mmole per g. of wood for the 1.0*N* alkali extraction. The carbonyl content of an alcohol-benzene extracted white birch wood meal was 0.195 mmole per g. of wood. Evidently a 0.1*N* NaOH solution is as effective in removing the carbonyl containing components as an alcohol-benzene extraction.

REACTIONS CONSUMING SODIUM BOROHYDRIDE DURING BLEACHING

The previous results have shown that extracted (alcohol-benzene or sodium hydroxide) white birch wood meal contains about 0.2 mmole per g. of wood carbonyl groups, while during bleaching of white birch cold soda with sodium borohydride in 0.1*N* NaOH

Table II. Distribution of Carbonyl Groups in Various Wood Species

Wood species	*Total extractives*			*Holocellulose*		*Lignin*	
	mmole/g.	*mmole/g.*	*%*	*mmole/g.*	*%*	*mmole/g.*	*%*
Spruce	0.112	0.033	29.4	0.043	38.4	0.036	32.2
Red oak	0.157	0.012	7.7	0.030	19.0	0.115	74.5
Yellow poplar	0.224	0.087	38.7	0.075	33.5	0.062	27.8
Beech	0.414	0.187	45.2	0.165	39.8	0.062	15.0
Sweet gum	0.165	0.027	16.4	0.094	57.0	0.044	26.6
Black gum	0.341	0.275	80.5	0.029	8.5	0.037	11.5
Poplar	0.100	0.038	38.0	0.032	32.0	0.031	30.0
White birch sapwood	0.252	0.027	10.7	0.141	56.2	0.084	33.1
White birch heartwood	0.595	0.382	64.0	0.182	30.5	0.031	5.5
Lignin sulfonic acid	0.286	. .	. . .	. . .	. . .	. . .	. . .
Periodate lignin	0.420	. . .	. . .	. . .	. . .	. . .	. . .

approximately 0.5% chemical (0.53 mmole/g. of wood) is consumed in a single-stage bleach. This shows that new reactions consuming sodium borohydride occur under alkaline conditions at elevated temperatures. Since brightness increases beyond consumption values of 0.2 mmole per g. of wood, it would seem that the reactions consuming sodium borohydride occur simultaneously with the bleaching reactions.

The effect of alkali on the degradation of polysaccharides has been reviews (*7*). Modification of the hemicellulose with alkali may occur by: (1) breaking of bonds between hemicellulose and other cell-wall components (if they occur), (2) alkaline hydrolysis of glycosidic linkages, (3) chemical degradation initiated at reducing groups, and (4) de-esterification of partially acylated polysaccharides. While white birchwood contains 4.5% acetyl groups (*8*), there is no evidence to suggest that these groups are reduced under alkaline conditions. In fact, since acetyl groups are readily saponified in alkali (*9*), their reduction as salts is more unlikely.

Since alkaline hydrolysis of glycosidic linkages occurs at elevated temperature this reaction does not enter under the experimental conditions employed (*7*). The evidence for linkages between hemicellulose and cell-wall components is not conclusive and, therefore, even if present, would only constitute a minor reaction consuming sodium borohydride (*10*).

The reaction most probably consuming additional sodium borohydride during the bleaching reaction is due to the alkali degradation of the polysaccharides initiated at reducing groups. During the "peeling" reaction new carbonyl groups are formed until a "stopping" reaction (formation of metasaccharinic acids), or until branched points at 1 → 2, or 1 → 3 linkages are encountered. The extent of new carbonyl groups formed, and hence the sodium borohydride consumption will depend, therefore, on the relative rates of reduction and degradation.

In addition to the different carbonyl groups in lignin which consume sodium borohydride (*3, 4*) the extractives, as shown, contain carbonyl groups, and these might be present to a greater extent in the cold-soda pulp after alkali treatment than in the wood meal. It is most likely that additional carbonyls may be formed on the interaction of alkali and extractives containing phenolic groups (*5*).

Previous work by Marton (*19*) has shown that the coloring matter deeply imbedded in the cell wall is

Table III. Effect of Alkali on the Carbonyl Content of White BirchWood Meal (2 ! r., 23°C.)

	NaOH equiv./l.	*Carbonyl values, mmole/g. Original*	*Final*	*Yield, %*	*Carbonyl extracted, %*
Unextracted heartwood	0.15	0.595	0.238	9.2	60.0
	1.0	0.595	0.226	23.97	56.0
Unextracted sapwood	0.15	0.292	0.221	8.4	27.0
	1.0	0.292	0.158	25.92	46.0

difficult to extract. However, although they are difficult to remove, the reactivity of these colored bodies depends on the intimate contact with the reducing or oxidizing reagent. It seems probable that elevated temperatures facilitating diffusion and extraction make these coloring materials accessible, thus increasing the sodium borohydride consumption. However, with the data available a quantitative determination of the new carbonyl groups cannot be made.

EFFECT OF SODIUM BOROHYDRIDE REDUCTION ON THE ALKALI EXTRACTABILITY OF WOOD MEAL

Recently, Schuerch and co-workers (*11, 12*) have studied in detail the alkali extraction of the softwoods, hardwoods, and straws. They interpreted the alkali extraction of the pentosans in terms of the accessibility and solubility of the pentosans in alkali. As bleaching with sodium borohydride is more favorable in alkali medium and at elevated temperatures, varying amounts of carbohydrate material may be extracted, resulting in lower bleached yields. It was, therefore, of interest to determine the extent of such losses occurring during sodium borohydride bleaching. However, instead of determining the yield of bleached pulp in the conventional manner, the effect of sodium borohydride pretreatment on the alkali extractability was studied using wood meal. By such experiments two difficulties are overcome; pretreatment, followed by extraction eliminates the difficulty of interpreting the results of two competing reactions: stabilization through reduction versus alkaline degradation. In addition, by using

wood meal the chemical effects are less likely to be obscured by the physical effects due to the gross fiber structure (*11*).

Table IV lists the results of the alkaline extraction of white birch and sprucewood and their holocellulose preparations, along with the results of pre-reduction of these samples. The reduction of these samples was done under unbuffered conditions with large excess of chemical. The temperature and alkali concentration were similar to the one used by Schuerch (*11*). It is seen that pre-reduction of white birchwood meal decreases the alkali extractability by 15% at room temperature and 30% at 80°C. while the reduction of white birch holocellulose reduces the alkali extractability by 22%. For sprucewood meal and its holocellulose component a decrease in the alkali extractability of 2% and 53%, respectively, were found in the pre-reduced samples. The increase in the alkaline extractability of the white birch holocellulose compared with that of the

Table IV. Effect of Sodium Borohydride Treatment on the Alkali Extraction of Wood Meal (24 hr., 23°C., 4% NaOH)

Sample	*Residue, % original*	*Residue pretreated, %*	*Increase, %*
Extracted white birch	68.51 ± 0.03	78.7 ± 0.85	15.0
Extracted white birch (80°C., 24 hr.)	56.0 ± 0.42	73.0	30.3
Extracted white birch (holocellulose)	58.1 ± 0.10	71.23 ± 0.75	22.5
Extracted Norway spruce	94.35 ± 0.20	96.13	1.81
Extracted Norway spruce (holocellulose)	56.28 ± 0.40	86.00 ± 0.40	53.0

whole wood most likely reflects the greater alkali accessibility of the pentosans when lignin is removed. The effect of lignin removal is much greater for spruce than for birch. The smaller effect on the alkali extractability due to sodium borohydride treatment found with sprucewood meal compared to birch may be due to the low accessibility of the sprucewood pentosans and mannans. However, once lignin is removed a very large increase results in the alkali extractability, and consequently yields, of the pre-reduced wood are greatly increased. Since it is well established that end group and carbonyl reduction of polysaccharides imparts alkali stability (*6*) it is reasonable to suggest that the increased yield is due to this effect. The consequence of this result is that the rate and, perhaps, the extent of the alkali extractability depends to some extent on the alkali degradation of the pentosans and mannans during extraction. Alternative explanations would be that changes in accessibility have occurred during reduction and that the acetyl groups, 4.35% for white birch and 1.34% for spruce (*8*), have been reduced and become resistant to alkali extraction. The latter explanation deserves verification.

While increased yields obtained by pretreatment of wood are due to the stabilizing effect of the sodium borohydride reduction, the stabilizing reaction competes with the alkali degradation reactions during bleaching. The final loss in material will be determined, therefore, by the relative rates of these two reactions. Assarsson (*13*) has found that pretreatment of pulp with sodium borohydride followed by alkali extraction results in a higher yield than a simultaneous extraction and reduction. This is probably due, in part, to the decreased rate of reduction of carbonyl groups in alkaline solution. The increased yields found with wood meal on reduction with sodium borohydride may not be found to the same extent using pulp, because the morphology of the fibers retards the extraction process. Nevertheless, an understanding of the chemical reactions occurring during sodium borohydride bleaching is necessary to control the bleaching variables and ensure maximum bleaching efficiency.

EFFECT OF BLEACHING CHEMICAL ON THE CARBONYL CONTENT OF WHITE BIRCH

The relationship of carbonyl groups to the color in wood and lignin has been investigated in several studies. Jones (*14*), investigating the consumption of peroxide in sprucewood components found that methylation with diazomethane or methanolic hydrochloric acid strongly inhibited the reaction with peroxide. He attributed this inhibition to the methylation of phenolic and carbonyl groups. A similar explanation was given by Brauns (*15*) for the inhibition of the hypochlorite reaction on a diazomethane methylated kraft or sulfite pulp. A 16 points brightness increment was noted on methylation of these pulps. Brightness increments on several types of pretreated groundwood pulps were also obtained recently on diazomethane treatment (*16*). While the methylation with diazomethane has been shown to form pyrazoline groups with coniferyl aldehyde (*17*), it was recently suggested (*2*), in view of the large color decreases obtained in the visible region on diazomethane treatment, that in addition to these groups quinoidal structure either of the 1,2 or 1,4 type are involved. The brightness increments obtained when pulp is treated with methanol-HCl or $CHCl_3$-HCl may also be explained by the 1,4 addition reaction with quinones (*18*).

Table V. Effect of Bleaching Chemicals on the Carbonyl Content of White BirchWood Meal

Wood	*Treatment*	*Carbonyl value mmole/g. Original*	*Final*	*% Decrease*
Unextracted white birch sapwood	$Na_2S_2O_4$	0.263	0.239	9
Unextracted white birch heartwood				
1st	$Na_2S_2O_4$	0.594	0.526	9
2nd	"		0.492	17
Unextracted white birch heartwood	CH_2N_2	0.594	0.079	87
Extracted white birch	1% H_2O_2	0.183	0.108	41
	9% H_2O_2	...	0.088	47
	45% H_2O_2	...	0.078	58
	1% NaOCl (pH 12)	...	0.118	36
	5% NaOCl (pH 12)	...	0.119	35
	3% $Na_2S_2O_4$	...	0.107	42
	10% $NaHSO_3$	...	0.087	47
	CH_2N_2	...	0.0395	78

To evaluate further the role of carbonyl groups in bleaching high-yield pulp, white birchwood meal was treated with the chemicals listed in Table V. It is seen that hydrosulfite reduces the sodium borohydride consumption both in the unextracted sapwood and heartwood and in the extracted whole wood. A second treat-

ment with hydrosulfite results in a further decrease in the sodium borohydride consumption. This again points to the important problem of accessibility during bleaching, especially since it is known that the coloring materials lie deeply imbedded in the cell wall (*19, 20*). It was noted that the color of the wood meal darkened soon after treatment with hydrosulfite, especially with the heartwood component indicating the instability of the reduced components.

Treatment of wood with peroxide resulted in a decrease in the sodium borohydride consumption of the residue to approximately 50% of the original value, while sodium hypochlorite treatment resulted in a 35% decrease. Sodium bisulfite gave a similar value. The residual carbonyl values for the peroxide- and hypochlorite-treated samples are somewhat surprising if one views these as oxidative reactions. Evidently not all the carbonyl groups are involved in these reactions.

While the decrease in the carbonyl content due to the peroxide, hypochlorite, and sodium bisulfite treatments are of the same order of magnitude, insufficient experimental proof is available to identify the type of carbonyl groups that are involved. In fact, while no handsheets were made with pulp from this wood, other experiments (*18*) showed that wide variation in brightness may be obtained with these chemicals.

Exhaustive methylation with diazomethane reduces the carbonyl content markedly compared to the other treatments. While the number of treatments definitely affect the residual carbonyl value, these results indicate the effectiveness of this reagent in eliminating carbonyl groups. Since diazomethane reacts only with 1,2-dicarbonyls, resulting in their elimination, it strongly suggests that these may be the principal groups reacting with diazomethane. These results also show that the number of carbonyl groups alone are not indicative of color or intensity.

EXPERIMENTAL

Materials and Procedures

Most of the brightness values corresponding to the consumption values in Fig. 1 were previously reported (*2*). The different wood species were obtained from several sources and were clearly identified. The heartwood and sapwood samples were sorted from chips. The holocellulose samples were prepared according to Timell (*21*). The alkali extraction experiments were determined using 1-g. samples and 100 ml. NaOH of the appropriate concentration. The same quantities were used when studying the effect of chemicals on the carbonyl content. Methylations were done in ether after solvent-exchange. At least four successive methylations were made before methylation was considered complete.

Analytical Methods

All wood analyses were done according to TAPPI Standards. Brightness values were obtained on a Hunter multipurpose reflectometer, using a blue filter. The carbonyl content of the various wood samples were determined according to Lindberg (*22*), and the iodate method (*23, 24*) was used to determine the sodium borohydride content in the bleaching experiments and in studying the decomposition of sodium borohydride in alkali at 50 and 75°C.

CONCLUSIONS

During the bleaching of white birch cold soda pulp with sodium borohydride in alkaline solution sodium borohydride is consumed by the lignin, extractives, and carbohydrates. The reduction of the lignin and extractives results in a 16-point brightness increment and corresponds to 40% of the total (0.53 mmole/g.) of wood chemical consumed during bleaching. The remainder is consumed in the reduction of the carbonyl groups formed during the alkali degradation of the polysaccharides, and perhaps new carbonyl groups made accessible because of temperature and swelling effects. Bleaching at higher temperatures utilizes the sodium borohydride more effectively than at lower temperatures. This is due to the greater accessibility at higher temperatures. Reduction of wood meal or holocellulose results in a decrease in the alkali extractability of the wood, the extent depending on the species and preparation. These results show that the rate of extraction and perhaps extent of extraction depends upon the degradation of the hemicellulose. Higher bleached yields may be obtained, therefore, by bleaching with sodium borohydride as compared to other alkaline bleaching processes. Pretreatment of white birch meal with diazomethane results in an 80% decrease in the carbonyl content. This indicates that 1,2-dicarbonyl groups may be present in wood and form part of the coloring matter. Treatment of white birchwood meal with other bleaching chemicals such as sodium bisulfite, sodium hydrosulfite, alkaline peroxide, and hypochlorite does not eliminate all the carbonyl groups, indicating that not all these groups form a part of a chromophoric system.

LITERATURE CITED

1. Mayer, W. C. and Donofrio, C. P., *Tappi* 43, No. 1: 238A–244A (1960).
2. Luner, P., *Tappi* 43, No. 10, 810–825 (1950).
3. Adler, E. and Marton, R., *Acta. Chem. Scand.* No. 1: 75–96 (1959).
4. Gierer, J. and Söderberg, S., *Acta Chem. Scand.* 13, No. 1: 127–137 (1959).
5. Erdtman, H., Granath, G., and Schultz, G., *Acta Chem. Scand.* 8, No. 8: 1442–1450 (1954); 8, No. 5: 811–816 (1954).
6. Meller, A., *Tappi* 36, 366 (1953); 38, 682 (1955).
7. Whistler, R. L. and BeMiller, J. N., in "Advances in Carbohydrate Chemistry," Vol, 13, New York, Academic Press Inc., 1958.
8. Timell, T. E., *Svensk Papperstidn.* 60, No. 20: 762–766 (Oct. 1957).
9. Rånby, B. G. and Noe, R. W., *J. Polymer Sci.*, in press.
10. Meerewether, J. W. T., *Holzforschung* 11, 65 (1957).
11. Nelson, R. and Schuerch, C., *J. Polymer Sci.* 22, 435–448 (1956).
12. Nelson, R. and Schuerch, C., *Tappi* 40, No 6: 419–426 (1957).
13. Assarsson, A., Stockman, L., Theander, O., *Svensk Papperstidn.* 62, 865 (1959).
14. Jones, G. W., *Tappi* 33, 149 (1950).
15. Brauns, F. E., *Paper Trade J.* 111, No. 14: 35 (1940).
16. Manchester, D. F., McKinney, J. W., and Pataky, A. A., *Svensk Papperstidn.* 63, No. 20: 699–706 (1960).
17. Kratzl, K. and Wittman, E., *Monatsh. Chem.* 85, 7 (1954).
18. Luner, P., Unpublished results.
19. Marton, R., *Tappi* 43, No. 10: 826 (1960).
20. Curran, C. E., Schafer, E. R., and Pew, J. C., *Paper Trade J.* 101, No. 8: 35–40 (1935).
21. Timell, T. E. and Jahn, E. C., *Svensk Papperstidn.* 54, 831 (1951).
22. Lindberg, B. and Theander, O., *Svensk Papperstidn.* No. 3, 83–85 (Feb. 1954).
23. Lyttle, D. A., Jensen, E. H., and Strock, W. A., *Anal. Chem.* 24, 1833 (1952).
24. Jensen, E. H., "A Study of Sodium Borohydride," NYT Nordiskforlag, Arnold Busck, Copenhagen, 1954.

Received May 12, 1961. Contribution No. 13 from the Empire State Paper Research Institute.

Papermaking Characteristics of Cedar Fiber

C. E. MURRAY and B. B. THOMAS

Western red cedar is a relatively unused species in the northwestern coastal forests. In preparation for its inclusion in a new commercial pulp grade, a comparative study was made of cedar, western hemlock, Douglas-fir, and southern pine. Fiber length, width, and wall thickness measurements showed cedar to have exceptional uniformity in these respects and to rank first in overall fiber fineness. Hemlock has shorter fibers of intermediate width and wall thickness. Douglas-fir sawmill waste (slabwood of old growth trees) has relatively coarse thick-walled fibers, while southern pine has a mixture of large, thin-walled, and smaller, thick-walled fibers. Paper tests were made on bleached kraft pulps from these woods, using both the Valley beater and the Lampen mill. The results were correlated by the quality criteria of Clark. Cedar is beaten least rapidly of the species, and is cut least in the beater. In those strength tests dependent on bonding; i.e., burst, fold, and tensile, the cedar pulp is highest by virtue of the fineness and flexibility of its fibers. The coarser Douglas-fir and pine are lowest. Tear strength is highest for the Douglas-fir and lower but about equal for the others. In sheet structural tests (density, opacity, air resistance, and smoothness) cedar is outstanding. The fine fibers allow a dense, tight sheet to be made with good opacity characteristics. The Lampen mill tests developed less burst and tear strength and a less tight sheet than the parallel tests in the beater. Second-growth Douglas-fir, which in some areas is significant in pulpwood supplies, is high in juvenile wood and does not have the high tear strength of the sawmill waste.

A STEADY broadening of the variety of wood species used in pulping is one of the historic trends of the American paper industry. In the early days, "Spruce was King," but this still valuable wood has lost its commanding position by the strong relative advance of other species. Today the largest single portion of the industry is based on the tough fibers of southern pine. Plantations of poplar in the Lake States contrast sharply with the status of this tree as a nuisance only 30 years ago.

In the Pacific Northwest, the first pulpwood of substantial importance was western hemlock, easily cooked and bleached but unwanted for lumber. Then ways were found to use the Douglas-fir scraps from sawmills. The tree now due for rapidly increased usage is western red cedar.

The trend to greater variety is partly based on economic factors. As logging costs increase and reserves are used it is necessary not only to get better returns on the trees brought from the woods, but also to use those formerly left behind. Modern conservation practice often follows the "area clear-cut" method. This requires the use of all that the land produces, so that new tree crops may be grown under optimum conditions of minimum competition.

On the other hand, papermakers now realize that no one fiber has everything—each kind of fiber offers distinct and unique properties. Changing demands have led pulp producers to examine closely the fiber properties of each species and to adapt these to the demands of papermakers for better and more specialized papers.

Until recently, cedar has indeed been an orphan tree. It grows in extensive stands, both pure and mixed, on the rainy coasts of Oregon, Washington, and British Columbia. Yet it has been cut only in limited amounts and primarily for lumber, where its durability is of value.

There have been only a few brief studies reported of the pulping of cedar. Early experiments at the Forest Products Laboratory (*1*, *2*) were followed by a comparative study of several northwestern and southern woods by the Institute of Paper Chemistry (*3*). Increased interest in cedar is shown by the appearance of four recent articles on pulping methods. These included trials with the kraft (*4*, *5*), sulfite (*8*), and modified sulfite (*7*) processes.

These pulping studies have shown that cedar gives a low yield in cooking. This would be expected from its low density and high extractive content. On the other hand, it cooks easily and the bleached fiber has unique and desirable properties. Papers made from cedar fiber have very high bursting, fold and tensile strength, and are tightly formed (low porosity, high density, and even distribution of fibers). Their tear strength is only a little lower than that of papers made from other western woods such as hemlock. Several western kraft mills are now using a small proportion of cedar in their furnishes, but there has been no commercial use in sulfite mills.

The newly reconstructed mill of Rayonier Canada Ltd., at Woodfibre, B. C., will be able to make a uniquely versatile series of kraft pulps from controlled mixtures including cedar, hemlock, and Douglas-fir. In addition, consideration is being given to production of a specialty grade of 100% cedar pulp. During development of the advanced process to be used at this mill, a study was made of the relative fiber properties of cedar and each of the other leading Northwestern species and of southern pine. The purpose of the work was to determine the optimum combinations and attractive features of each special blend. This report deals with the correlation of these properties for the individual woods with characteristics of papers made from the fibers.

The general subject "Fiber Properties versus Paper Characteristics" has been much discussed in recent times. The importance of individual fiber dimensions was, of course, realized long ago. More recently, however, these factors has been related to fundamental strength measurements and their significance has become better understood. Dadswell (*8*, *9*) and Besley (*10*) have reviewed the present knowledge of such relations, and emphasized the desirability of long, thin fibers for certain papers. The importance of variations

C. E. MURRAY, Research Chemist, and B. B. THOMAS, Papermaking Group Leader, Olympic Research Division, Rayonier, Incorporated, Shelton, Wash.

Table I. Pulpwoods and Wood Characteristics

Sample identity	Log diam., in.	Growth rate, rings/in.	Specific gravity
Western red cedar (*Thuja plicata*)			
Whole logs no. 1	20–36	10–90	0.32
Whole logs no. 2	18–24	8–20	0.32
Western hemlock (*Tsuga heterophylla*)			
Mill-run logs	15–30	5–20	0.40
Douglas-fir (*Pseudotsuga menziesii*)			
Old-growth slabwood	Over 30	8–20	0.45
Second-growth logs	12–18	3–6	0.38
Southern pine (*Pinus elliotti, P. palustris*)			
Plantation stock	5–10	6–10	0.48

in wood density has been brought out by Wangaard (*11*).

Clark (*12*) has formalized these relations by identifying major fiber properties which can be measured and related to paper quality. His criteria were used to evaluate woods and pulps of the papermaking species of prime interest in the present study.

EXPERIMENTAL

Wood Samples

A comparative examination was made of the wood samples described in Table I. The woods were obtained from logging operations in the producing areas. They were typical of supplies which come to the mills from the available forests.

Because of the importance of cedar in the present study, two samples of this wood, of slightly different size and growth-rate ranges, were included. Douglas-fir now comes chiefly as sawmill wastes, and a sample representing this source is used in the comparisons following. Second-growth supplies of this species will become more important in the future, and are different from the old-growth wood in several important respects. This type was also examined; the resulting changes in Douglas-fir's status are discussed in a separate section of this paper.

Microscopic Examination

Figures 1 and 2 are photographs of typical cross-sections of each of the four species of wood, and representative individual springwood and summerwood fibers isolated from unbleached kraft pulps of each species.

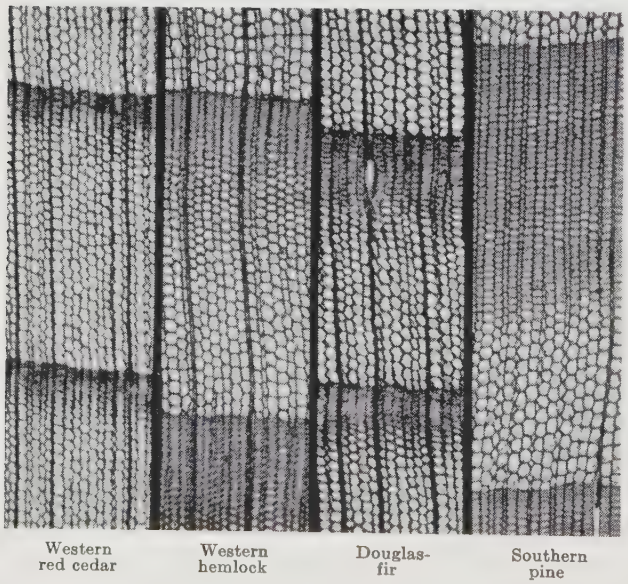


Fig. 1. Cross-sections of wood samples. Magnification 33×

Fiber-length measurements were also made on these unbleached kraft pulps. Random selections of 100 to 200 unbroken fibers from each sample were measured by a method previously described (*13*). The results are plotted in Fig. 3 as numerical frequency distributions at 0.5-mm. intervals.

Diameter and wall thickness were measured in terms of their variation across the annual ring. From 10 to 15 ring samples were selected from various parts of several logs of each species and type, to average their radial and longitudinal variations. Photographs of cross-sections were examined at a final magnification of 1400×. In each selected ring, five fibers were meas-

Fig. 2. Typical fibers of wood species. In each pair, left, springwood; right, summerwood. Magnification 45×

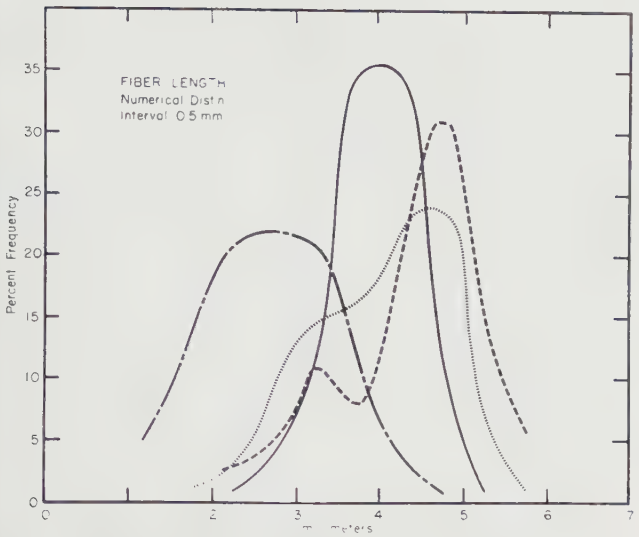


Fig. 3. Numerical fiber length distributions

Cedar ——— Hemlock — - — - — -
Douglas-fir - - - - - So. pine .....

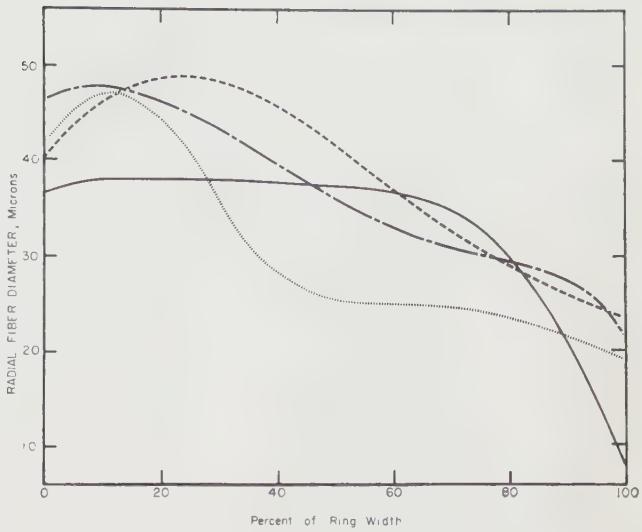


Fig. 4. Radial fiber diameter variation across the annual ring

Cedar ——— Hemlock — - — - —
Douglas-fir - - - - - So. pine .....

ured at each 10% interval of width. Average radial diameter and wall thickness are shown in Figs. 4 and 5.

Pulping and Bleaching

Wood samples typical of each of the descriptions in Table I were chipped, screened, and cooked to a suitable permanganate number by an advanced kraft process in a 6-cu. ft. laboratory digester. After screening, the pulps were bleached by a multistage sequence.

Paper Testing

The undried pulp samples were beaten in two quite different machines—the Valley beater and the Lampen mill. The beater used had been maintained since it was new with Dinger's 80-grit touch-up technique (*14*), with very good uniformity resulting therefrom. The beating procedure followed TAPPI Standard T 200 m-45, with modifications previously described (*15*) as necessary to obtain suitable test samples.

The beater tests and freeness measurements were made in laboratory tap water. Although this is a relatively soft water, beating times to a uniform C.S. freeness of 400 ml. were 10 to 15 min. longer than would have been required in deionized water. A study of the effects of water composition on beating was published in 1960 (*15*), with the hope that a change in the standard method could be effected.

The Lampen mill, used for parallel tests, was charged with 24-g. samples at 3% consistency, and operated at 250 r.p.m. The samples were dispersed before and after milling with the TAPPI disintegrator.

Each interval sample from either machine was divided for freeness tests and handsheets, which were made, dried, and tested according to TAPPI Standard Methods. Routine tests made included burst, tear, fold, tensile and stretch, density, opacity, and air resistance. In addition, tests were made for zero-span tensile strength. Smoothness was determined on some samples, using four layers of paper all laid with the smooth side down. Clark classifier tests were made on the freeness test pads after drying and reslurrying.

Figures 6–13 show the data from most of these tests. The physical properties are plotted, with one exception, against beating time. Abstracts at uniform C.S. freeness of 400 ml. are given in Tables II to IV. All data are converted to TAPPI standards of basis weight and ovendry condition, and are calculated according to TAPPI formulas.

After completion of the tests on individual wood species, two samples in which the species were blended were also prepared. Test data on these are abstracted in Table IV. One sample was made as a blend of chips, cooked, and bleached together. The other was made by blending in the beater the same proportions of separately prepared pulps.

DISCUSSION

Wood Supplies

The wood samples were chosen to be representative of the supplies which normally come to the pulp mills. Cedar is used primarily in whole-log form; sawmill wastes of this species are of relatively minor importance. The two samples represent stands of different tree size,

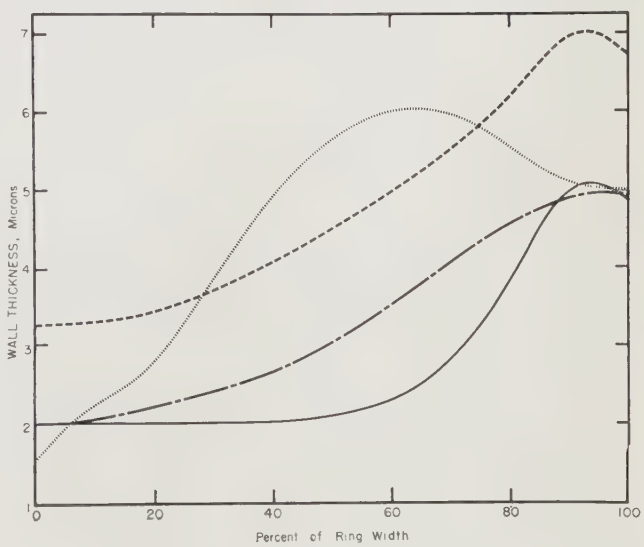


Fig. 5. Fiber wall thickness variation across the annual ring

Cedar ——— Hemlock — - — -
Douglas-fir - - - - - - So. pine .....

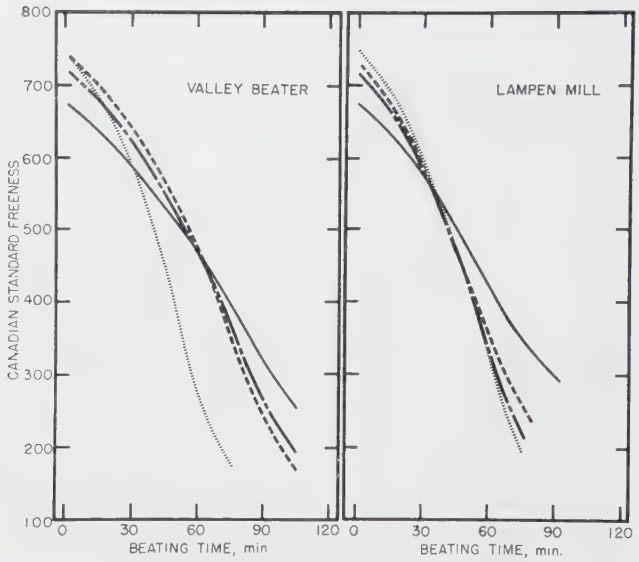


Fig. 6. Canadian Standard freeness vs. beating time

Cedar ——— Hemlock — - — - —
Douglas-fir - - - - - - So. pine .....

but both had a slow growth rate and low density. They were not distinguishable in the fiber measurements, and while strength and sheet tests for both are given in Table IV, they differed significantly only in tear strength and only no. 1 cedar sample is shown in Figs. 6 to 13. A true second-growth supply of cedar will not be a significant factor in logging from company lands for more than a quarter century. A stable supply is therefore assured for some time to come.

Since Douglas-fir is more important for lumber than for pulping, mill wastes (slabs, edgings, etc.) are available in large quantity and constitute the main pulp source of this species. The typical sample used, therefore, represents primarily the outer portions of the original logs. Further discussion on this species appears in a separate section below.

Hemlock, being primarily a pulpwood tree, comes as woods-run logs. It grows at medium rates, and large stands of relatively uniform ages are available.

Southern pine was included as an established wood source of quite different nature. Most pine used for pulping is relatively young natural or planted second-growth timber.

Microscopic Examination

The comparative microscopic views and data of Figs. 1 to 5 show cedar fiber to be outstandingly uniform in length, diameter, and wall thickness. This uniformity of cedar was maintained through about two-thirds of the year's growth, and was observed in rings ranging from only a few to over 100 cells in width. The cedar was also distinguished by having the thinnest fiber walls of the four species studied.

Compared with cedar, hemlock and pine have much broader distributions of fiber length. Hemlock and Douglas-fir both showed steady declines in fiber diameter from early season peaks, and more gradual increases in wall thickness than cedar. A sharp seasonal transition is the characteristic feature of pine. The abrupt change from large, thin-walled fibers to smaller, thick-walled ones is evident from the figures. The heavy late fibers sometimes give pulps a coarse quality.

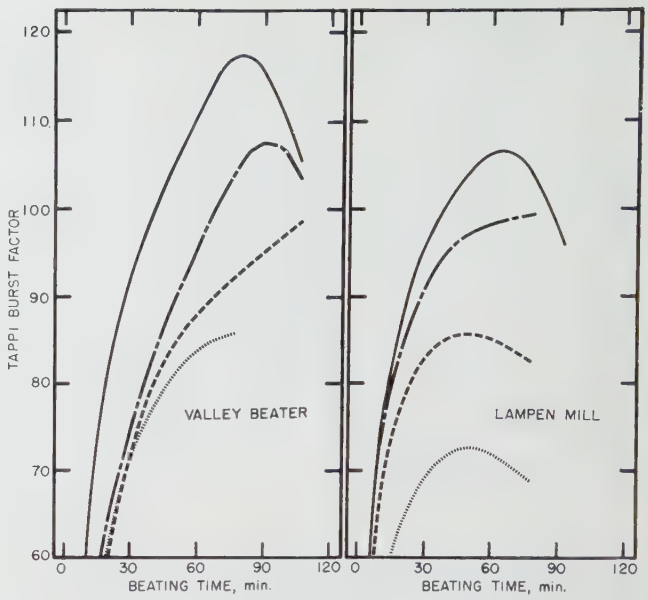


Fig. 7. TAPPI burst factor vs. beating time

Cedar ——— Hemlock — - — - —
Douglas-fir - - - - - - So. pine .....

Radial fiber diameter and wall thickness vary more from early to late in each season than they do with radius or height of the whole tree. Variations of tangential fiber diameter and fiber length were also checked across the individual ring. Tangential diameter does not vary significantly at this scale. Annual length variations for cedar, hemlock and pine were only 5 to 10% of the average length, in accord with data of Bisset and Dadswell (*16*) on other conifers, including Douglas-fir.

Paper Strength Tests

Freeness. In both beating machines, cedar was distinguished from the other fibers by its resistance to change in freeness (Fig. 6). Characteristically, it had lower initial freeness than the other pulps, as a result of the fineness and flexibility of the cedar fibers. But after 50- to 80-min. beating all the other fibers had been cut and fragmented more than the cedar and showed

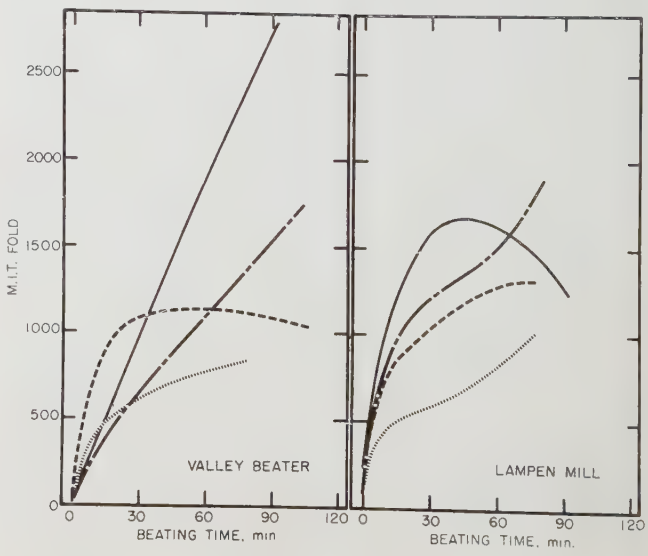


Fig. 8. Double folds, MIT, vs. beating time

Cedar ——— Hemlock — - — - —
Douglas-fir - - - - - - So. pine .....

Table II. Fiber Classification Data; Clark Classifier

Fractions	Unbeaten pulp			Valley beater, C.S.f. 400 ml.			Lampen mill, C.S.f. 400 ml.		
	Whole fiber	Broken fibers	Fines	Whole fiber	Broken fibers	Fines	Whole fiber	Broken fibers	Fines
Cedar, no. 1	83	13	4	83	12	5	74	18	8
Cedar, no. 2	83	12	5	83	10	7	75	16	9
Hemlock	82	11	7	77	12	11	75	10	15
Douglas-fir, old growth	88	7	5	77	16	7	75	16	9
Southern pine	83	12	5	78	15	7	71	20	9

lower freeness readings. This distinction was strongest in the Lampen mill, in which all the pulps other than cedar beat at nearly the same rate. The beater test indicates pine to be faster beating than any others in this group.

A measure of the cutting and fragmentation in the beater is found in the Clark classifier data in Table II. The whole fiber, fiber fragments, and fines fractions, as defined by Murray (*13*), are shown for the unbeaten pulps and after beating to a C.S. freeness of 400 ml. Cedar maintained a higher percentage of long fibers in the beater than the other species, and developed fewer fines than hemlock. Since the cedar developed good strength in spite of this lack of change, it is concluded that on these thin, flexible fibers more of the beating work goes into fibrillation and less into cutting. In the Lampen mill the effect on the fiber is evidently different. There is more fragmentation of most of the samples, indicating a lower potential paper strength.

Bonding Tests. Three common paper tests which are considered to be dependent primarily on interfiber bonding strength are the burst factor, fold, and breaking length. In all these tests (Figs. 7 to 9), the cedar showed highest strength by either method of beating. Hemlock and Douglas-fir were intermediate, and southern pine normally lowest. Furthermore, in the early part of the beating, cedar clearly attained burst strength development more quickly than the other species. The order of strength preference is the same as that found for fiber thinness, and hence for flexibility, and certainly results from the better bonding that is obtained with more flexible fibers.

Zero-span tensile tests, made on the Valley beater

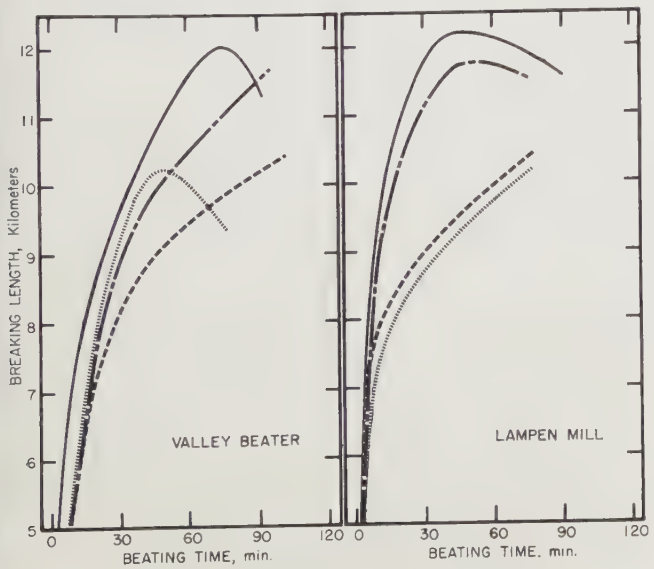


Fig. 9. Breaking length vs. beating time

Cedar ——— Hemlock — - — - —
Douglas-fir - - - - - - So. pine .....

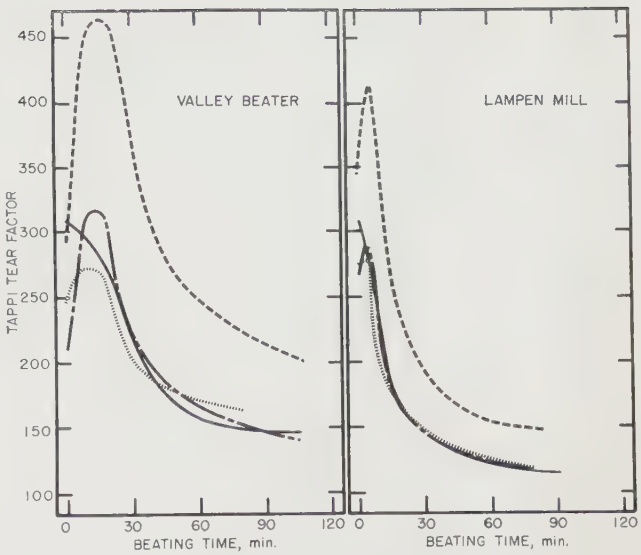


Fig. 10. TAPPI tear factor vs. beating time

Cedar ——— Hemlock — - — - —
Douglas-fir - - - - - - So. pine .....

sheets, gave such uniform results after the first 15 min. of beating that they were not plotted The test values at 400 ml. C.S. freeness are listed in Table II. The small variations shown do not correlate with other properties and may not be of significance.

Tear. Tear factor is more clearly a function of fiber length, and may even be reduced by very firm bonding. Figure 10, typical tear curves, shows that the Douglas-fir slabwood fiber is much the highest in this quality. But this advantage, as subsequent comment shows, is definitely not shared by the second-growth fir.

Pulp tests normally show a tear-strength increase in the first part of the beating. This is considered to be due to improved bonding, dispersion, and straightening of the fibers, so that best advantage of their length can be taken. Thereafter the tear drops as fibers are cut, and bonding increases further. Remarkably, the cedar samples do not show this peak. The reason may be as follows: in the early beating period, cedar had 50 to 80% higher burst than other pulps. Its finer, more numerous fibers are more easily dispersed to a well-formed, well-bonded sheet. Thus, the rapid development of bonding by the cedar gives it its peak tear quality at or near the unbeaten state, with little opportunity to take advantage of its good length.

Sheet Structural Tests

Sheet structural tests included density, air resistance, smoothness, and opacity.

Density. This test (Fig. 11) is an indicator of compaction attained in pressing, and Clark (*12*) has pointed out that it therefore shows the wet flexibility of the fibers. He has recommended the comparison of strength tests at equal density, but in the present group of results this could not be done. A density of 0.70 g./cc., for example, was reached by old-growth Douglas-fir only after 110 min. beating and at a C.S. freeness below 200 ml. At the other extreme, cedar pulps gave this same density after 15 min. beating, at a C.S. freeness above 600 ml. No reasonable comparison could be made over such a range. The close packing of the cedar fibers gives, with high density, the greatest

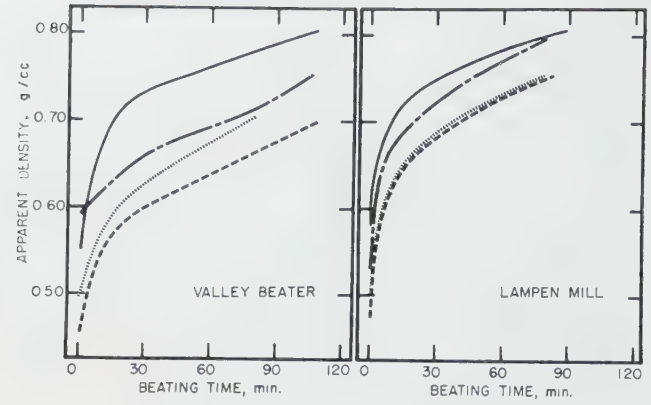


Fig. 11. Sheet density vs. beating time

Cedar ———
Douglas-fir - - - - - -
Hemlock — - — - —
So. pine .....

opportunity for bonding and predicts the good strength already discussed.

Porosity. Air resistance was found previously (*15*) to be a sensitive guide to the effect of water quality. The same test was unexpectedly revealing in this study also. When plotted on a logarithmic scale against beating time, the air-resistance data changed linearly, with slopes evidently related to the rate of beating. When plotted against C.S. freeness (Fig. 12) the samples all showed equal slopes from about 550 to 250 ml. freeness. Thus in this freeness range there is a nearly tenfold difference (Table IV) between cedar and pine in the air permeability of dry sheets made from pulps having the same freeness, and therefore a similar permeability of the wet fibers during sheet formation.

Such a great difference in porosity must be related to the behavior of the fibers in the intervening wet pressing and drying steps. The more flexible the fibers, the more readily they will deform around one another under the forces of pressing and of surface tensions during drying. Areas of contact and potential bonding are thereby increased and porosity decreased. Since the ranking of the group is the same in this respect as

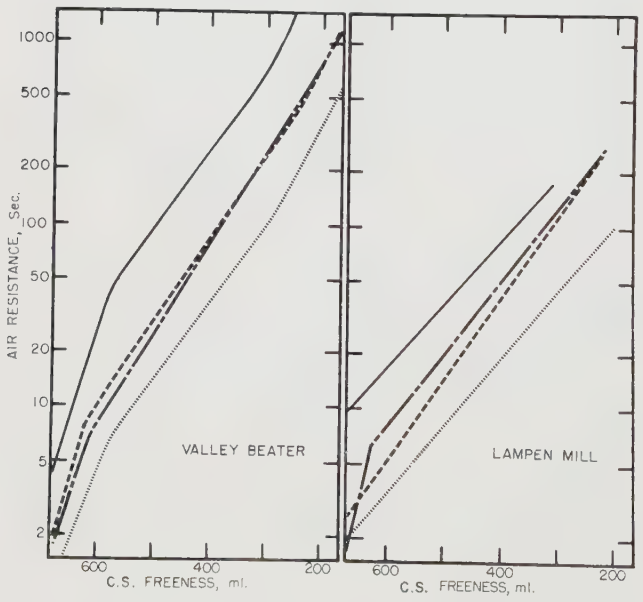


Fig. 12. Air resistance (log scale) vs. Canadian Standard freeness

Cedar ———
Douglas-fir - - - - - -
Hemlock — - — - —
So. pine .....

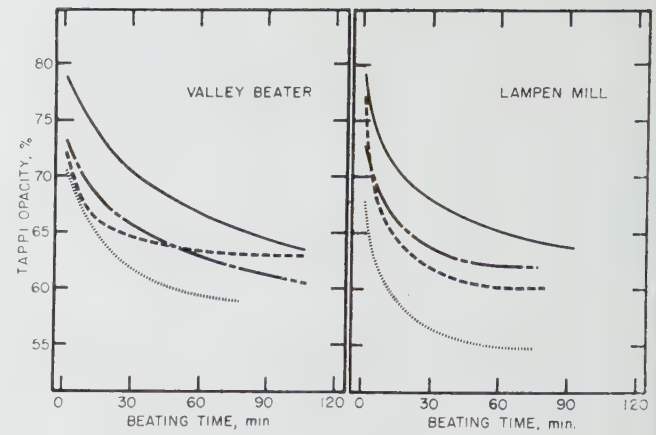


Fig. 13. TAPPI opacity vs. beating time

Cedar ———
Douglas-fir - - - - - -
Hemlock — - — - —
So. pine .....

in strength tests, it is implied that given fiber contacts, bonding follows equally in all fiber types. The highly flexible cedar is best able to take advantage of this relation.

Lampen mill sheets showed analogous air resistance differences, but both the slopes and maximum resistance were lower. This appears to correlate with the generally lower strength development found in Lampen mill beatings.

Smoothness data (Table IV) showed only small changes with beating after initial compaction. As with air resistance, cedar with its fine fibers gave highest smoothness.

Opacity. Like density and air resistance, opacity varies with the compaction of the sheet. Opacity tests (Fig. 13) again gave the highest rank to cedar fibers. This is somewhat anomalous at first sight. Normally, increased sheet density and reduced porosity are accompanied by lower opacity as the fibers are brought together and optical surfaces disappear. But, as Table IV shows, cedar is capable of making a sheet that is thinner, denser, and tighter, but which still retains more opacity than sheets made from the

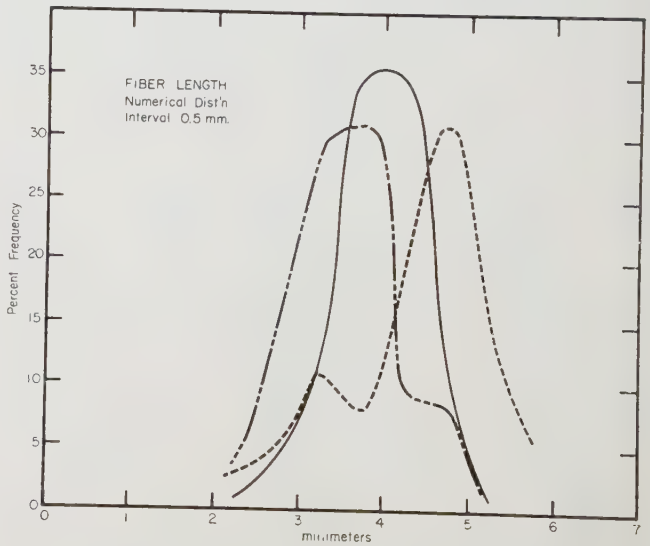


Fig. 14. Numerical fiber length distributions

Cedar ———
Douglas-fir, old growth - - - - - -
Douglas-fir, second growth - - — - - — - -

Table III. Comparison of Wood Species in Microscopic and Paper Tests; Clark's Quality Criteria

Criterion and characteristic	Cedar no. 1	Cedar no. 2	Western hemlock	Douglas-fir, old	Douglas-fir, 2nd	Southern pine
1. Fiber length						
Weighted av., mm.	4.0	4.0	3.0	4.2	3.5	4.0
2. Dry flexibility						
Fiber diam., μ	34.5	34.5	35	36.5	33	33
Wall thickness, μ	2.8	2.8	3.2	4.7	3.3	4.5
Solid fraction, %	30	30	33	45	36	49
3. Wet flexibility						
Sheet density, g./cc.[a]	0.78	0.79	0.71	0.65	0.71	0.66
4. Fiber cohesion						
Normal tensile, m.[a] / Zero-span tensile, m.	0.81	0.82	0.75	0.56	0.67	0.69
5. Intrinsic fiber strength						
Zero-span tensile, m.[a]	15,050	15,100	16,000	16,650	15,200	15,350
6. Response to beating (see Table IV)						

[a] Beaten to C.S.f. 400 ml.

other fibers. Here the important factor is the greater number of thinner fibers which are present in the cedar. In finished papers the requirements for filler pulps for smoothness and loading for opacity should be reduced when cedar is present, with the added advantage of a gain in strength.

Douglas-Fir Second Growth

The preceding comparisons have included a sample of Douglas-fir taken from sawmill wastes, typical of the supply now used at the pulp mill. However, this tree species springs up and grows rapidly on cutover or open ground. Increasingly, second-growth Douglas-fir is available from thinnings on lands managed under the modern Tree Farm system A sample of this type was therefore included in the present study. Microscopic and strength-test data are shown in the tables with the other samples.

Second-growth Douglas-fir is quite a different wood from the slabwood of old trees found in sawmill wastes. Its very rapid growth results in quite different wood characteristics, including wider annual rings of thinner walled fibers, as shown in Tables I and III. Fiber diameter of the sample examined was slightly below that of the Douglas-fir old growth in Fig. 4, with the same trend. Fiber-wall thickness was similar to that of hemlock in Fig. 5, but with a more abrupt seasonal transition, and therefore much less than the wall thickness of the other Douglas-fir sample.

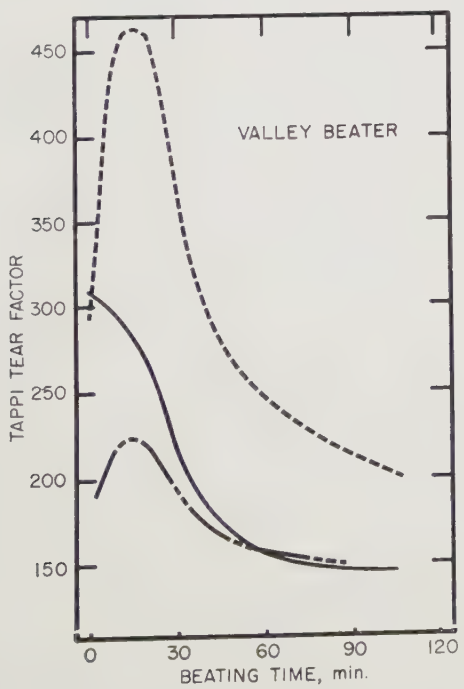


Fig. 15. TAPPI tear factor vs. beating time
Cedar ———
Douglas-fir, old growth - - - - - -
Douglas-fir, second growth — - - — - - —

Fiber-length distribution for cedar and the two types of Douglas-fir are shown in Fig. 14. The difference between the two Douglas-fir samples is due largely to the high proportion of core, or juvenile wood in the second-growth sample. The first several years' growth of most trees, at any height, is now known to contain shorter fibers than later rings (*8*). For Douglas-fir (*17*), hemlock (*18*), and pine (*19*), this has been previously documented. Our studies have indicated that, perhaps because of slow growth, the relative proportion of short-fiber core wood in cedar is very small.

In strength testing, these variations in fiber quality most significantly affected freeness, density, and tearing strength. Differences in fold and tensile strength were smaller, and in burst, opacity, and air resistance very small.

The second-growth Douglas-fir beats to a low freeness much more rapidly than the old-growth slabwood, and in Fig. 6 would closely match the curve for pine. Because it had many thin-walled fibers it formed denser sheets (between cedar and hemlock in Fig. 11) with a little higher air resistance, but about the same opacity as the old growth. The two Douglas-fir fibers were entirely different in tear strength. They are compared with cedar in Fig. 15, where it is evident that loss of fiber length and wall thickness has cut tear factor by 20 to 50% in the second-growth sample. Therefore, as the proportion of Douglas-fir supply shifts gradually to second-growth wood in future years, this wood will lose some of the advantage in tear that it now has.

Clark's Quality Criteria

A more unified view of these comparisons between wood species may be obtained from the fundamental quality criteria proposed by Clark (*12*). The pertinent data are collected in Table III.

The average fiber length, diameter, and wall thickness are derived from the data shown in Figs. 3 to 5 and 14. Length is Clark's first criterion of quality. The length and wall thickness figures reflect actual differences well, but the diameter figures shown are averages

Table IV. Summary of Paper Testing in the Valley Beater At Constant 400 ml. C.S. freeness

	Cedar no. 1	*Cedar no. 2*	*Western hemlock*	*Douglas-fir, old*	*Douglas-fir, 2nd*	*Southern pine*	*Blend[a] of chips*	*Blend[a] of pulp*
Beating time, min.	75	67	70	69	44	48	62	75
TAPPI Burst factor	118	110	101	90	83	81	101	105
TAPPI Tear factor	143	126	154	197	170	176	145	167
Double folds, MIT	1,900	1,950	1,300	1,200	1,300	665	1,900	1,950
Breaking length, m.	12,100	12,400	12,000	9,300	10,150	10,550	11,800	11,250
Density, g./cc.	0.78	0.79	0.71	0.65	0.71	0.66	0.77	0.75
Air resistance, sec.	250	325	85	90	100	35	150	150
Smoothness, sec.	30	37	22	14	18	11	23	20
Opacity, %	66	66	62	64	63	61	65	68
Stretch, %	4.5	4.8	3.5	4.6	4.1	3.5	4.4	4.7

[a] Blend composition: 30% cedar, 55% hemlock, 10% Douglas-fir (old-growth slabwood), 5% Sitka spruce.

for both radial and tangential directions. They conceal the great differences between the uniformly sized cedar fibers and the mixture of thick and thin pine fibers, as is apparent in Fig. 1. Diameter and wall thickness data have been combined to give the solid fraction value of the fibers, as a measure of their fineness and of the dry fiber flexibility, the second criterion. It shows clearly the advantages of cedar in this regard. Several other calculated indexes were also used to compare the fibers; in general, they confirmed this comparison.

The next criterion is wet flexibility, interpreted through compaction of the sheets in pressing and drying. This factor was discussed above, the cedar showing a high density and air resistance indicative of close fiber packing.

The fourth test is fiber cohesion. One way of measuring this is the ratio of normal- to zero-span tensile strength (*12*). The zero-span tensile is itself the measure of intrinsic fiber strength, the fifth criterion. These quantities are both shown in Table III. The tensile ratio graded the pulp species in much the same way as the previously cited quantities. Zero-span tensile, as was previously noted, gave little distinction among the species.

Another quantity important in cohesion is the specific surface of the fibers. In 1950, Browning and Baker (*21*) determined surface by the silvering method on unbleached kraft pulps from a similar group of wood species. After short beatings they ranked the pulps in the order: cedar, hemlock, loblolly pine, and Douglas-fir, the cedar having 30 to 50% more surface than the other species.

Clark's final criterion is response to beating. Table IV summarizes the results of these tests. Cedar pulps showed high strength in the tests dependent on bonding, but was somewhat lower in tear. In density, air resistance, smoothness, and opacity it was consistently higher than the other species tested.

Pulp Blends

After the experiments on pulps of single wood species, were two with blended species. They represented the type of product to be made industrially from these woods. The composition used was 30% cedar, 55% hemlock, 10% Douglas-fir slabwood, and 5% Sitka spruce. The spruce occurs in smaller quantity in the coastal forests; separate tests are not shown but it resembles hemlock. The blend showed sheet qualities and strength intermediate between those of the species used, but much of the potential advantage of cedar was obtained with 30% of this wood in the furnish.

A trial calculation was made to test the assumption that each species contributed to the strength and other tests in proportion to its presence. The resulting "synthetic" data were not in agreement with those on actual blends, and especially gave low values in the sheet structural tests for which cedar is best. The invalidity of such a prediction of blend properties was recently confirmed by Thode (*20*). It was concluded that cedar contributes more than its weight proportion of its fiber properties to a mixed furnish. Evidently the flexible cedar fiber has a significant ability to conform around stiffer fibers of other species to contribute more than its proportion to bonding and sheet closure.

SUMMARY

An evaluation was made of the papermaking properties of western red cedar relative to western hemlock, Douglas-fir, and southern pine. Fiber dimensional data ranked cedar first in overall fiber flexibility and fineness; hemlock was intermediate; Douglas-fir and southern pine were lowest in these qualities.

Paper tests on bleached kraft pulps from these species were made in parallel in the Valley beater and the Lampen mill. The beater tests confirmed the unique position of cedar. This species ranked first in burst, fold and tensile properties, which are dependent upon the interfiber bonding of highly flexible fibers. Cedar also ranked first in opacity and smoothness owing to the fineness of its fibers.

In contrast, the coarse, stiff fibers of Douglas-fir placed this species high in tear while hemlock, with intermediate fiber properties, generally ranked with the cedar and the pine.

Cedar was slower beating than the other species as measured by C.S. freeness, but fiber classification tests indicated this may be due to the resistance of cedar to fiber cutting during beating.

Paper tests in the Lampen mill showed parallel results, but did not develop as much strength or tightness of sheet structure. The Lampen mill reduces fiber length more than the beater.

When cedar, hemlock, and Douglas-fir are blended, the fiber properties of the individual species may be combined to produce a pulp of balanced properties, particularly high in burst and tear. The Douglas-fir contributes tear strength while the burst and tensile are principally derived from the cedar and hemlock. The cedar also contributes materially to a closed sheet structure with good opacity.

Second-growth Douglas-fir, which will be a growing factor in the future supply of this species, does not have the same fiber characteristics as old-growth slabwood, and does not possess the high tear-strength potential of the latter type.

In general, when present in a paper furnish, cedar contributes good bonding strength, close structure, smoothness, and opacity. For many papermaking purposes such mixtures of northwestern wood species will offer the possibility for many blends in balanced proportions. For the product requiring exceptional smoothness qualities, the special grades of high cedar content or even of pure cedar fiber should be considered.

LITERATURE CITED

1. Wells, S. D. and Rue, J. D., "Suitability of American Woods for Paper Pulp," U. S. Dept. Agr. Bull. 1485, p. 43–46 (1927).
2. Bray, M. W. and Martin, J. S., *Paper Trade J.* 125, No. 16: 40–46 (Oct. 16, 1947).
3. Holzer, W. F. and Booth, K. C., *Tappi* 33, No. 2: 95–98 (1950).
4. Christiansen, C. B., Hart, J. S., and Ross, J. H., *Tappi* 40, No. 5: 355–61 (1957); *Pulp and Paper Mag. Canada* 58, No. 1: 103–109 (1957).
5. Wilson, J. W., Worster, H., and O'Meara, D., *Pulp and Paper Mag. Canada* 61, No. 1: T19–24 (1960).
6. Wethern, J. D., *Canadian Pulp and Paper Ind.* 12, No. 9: 23, 24, 26, 28, 30, 32 (Sept., 1959).
7. Wilson, J. W. and O'Meara, D., *Pulp and Paper Mag. Canada* 61, No. 4: T259–262 (1960).
8. Dadswell, H. E. and Wardrop, A. B., *Pulp and Paper* 33, No. 4: 117–121 (1959).
9. Dadswell, H. E., Watson, A. J., and Nicholls, J. W. P., *Tappi* 42, No. 7: 521–526 (1959).
10. Besley, L., *Pulp and Paper Mag. Canada* 61, No. 7: 136–140, 142, 146, 148 (1960).
11. Wangaard, F. F., *Norsk Skogindustri* 12: 286–95 (1958).
12. Clark, J. d'A., *in* "Cellulose and Cellulose Derivatives," 2nd ed., Part II, p. 626–633, New York, Interscience, 1954.
13. Murray, C. E., *Tappi* 39, No. 4: 176A–180A (1956).
14. Dinger, F., *Tappi* 37, No. 10: 183A–187A (1954).
15. Thomas, B. B., *Tappi* 43, No. 5: 447–454 (1960).
16. Bisset, I. J. W. and Dadswell, H. E., *Australian Forestry* 14, No. 1: 1950, 13 pp.
17. Anderson, E. A., *J. Forestry* 49: 38–42 (1951).
18. Wellwood, R. W., *J. Forestry* 48: 361–68 (1960).
19. Texas Forestry Service, Tech. Rep. 10 (1957).
20. Thode, E. F., *Pulp and Paper Mag. Canada* 62, No. 3: T195–200 (1961).
21. Browning, B. L. and Baker, P. S., *Tappi* 33, No. 2: 99–101 (1950).

Received May 23, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

Contribution No. 59 from the Research Divisions of Rayonier, Inc.

Measuring and Specifying Bulge and Crush Resistance in Cartons and Carton Board

PAUL COPE

Instruments were developed for measuring the bulge and crush resistance of cartons and carton board. These instruments were used to establish the strength requirement for two sizes of seal end cartons carrying a free-flowing product by studying more than 200 mill runs of board that had been made into cartons for a product sold nationally. New boards and cartons made from the new boards could then be quickly and equitably evaluated when compared to the reference data. Some new boards were found to have greater bulge and crush resistances than would have been expected from their weight and caliper. This has opened new areas for investigation to board and carton makers and to carton users.

When folding cartons are specified on a strength basis, board and carton makers have a new dimension in the use of their materials and processes, and carton users can quickly evaluate boards and finished cartons. This paper will discuss ways of measuring the bulge and crush resistances of seal end cartons.

Cartons carrying free-flowing products need bulge resistance to maintain appearance and to prevent the package from appearing underfilled. Cartons can be filled with product and the bulge measured, but this is time-consuming and is not accurate enough to measure small, yet important, differences in board. Such a test would also be impractical to use in a board mill, the point where bulge resistance is built into the board. This led to the development of the Bulgemeter (Fig. 1).

The Bulgemeter measures bulge resistance by gently pressing a sample of board into a given frame with a specified pressure, and measuring the resulting deflection which is called bulge value. Figure 2 shows how the bulge value changes for a given board as the frame size and the pressure change. When the frame opening is made to correspond to the carton face and the pressure is made to simulate the pressure of the product causing the carton to bulge, the effects of carton size and product density on bulge can be determined.

Two widely used carton sizes were chosen for study; one, coded "A," has an $8^1/_2$ by 6 in. face and carries approximately 22 oz. of a product with a density of about 0.4 g. per cc.; the other, coded "B," has an 11 by $8^3/_{16}$-in. face and carries approximately 54 oz. of the same product. The frame-opening size for each carton was determined by cutting the largest sample possible

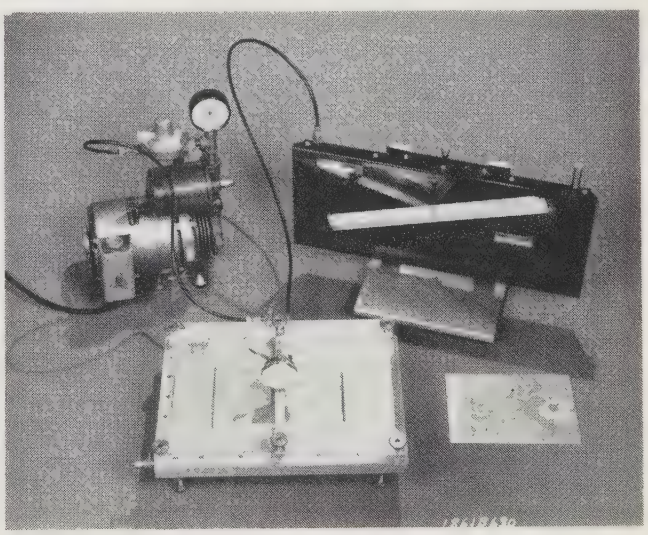


Fig. 1. The Bulgemeter

Paul Cope, Procter and Gamble Co., Cincinnati, Ohio.

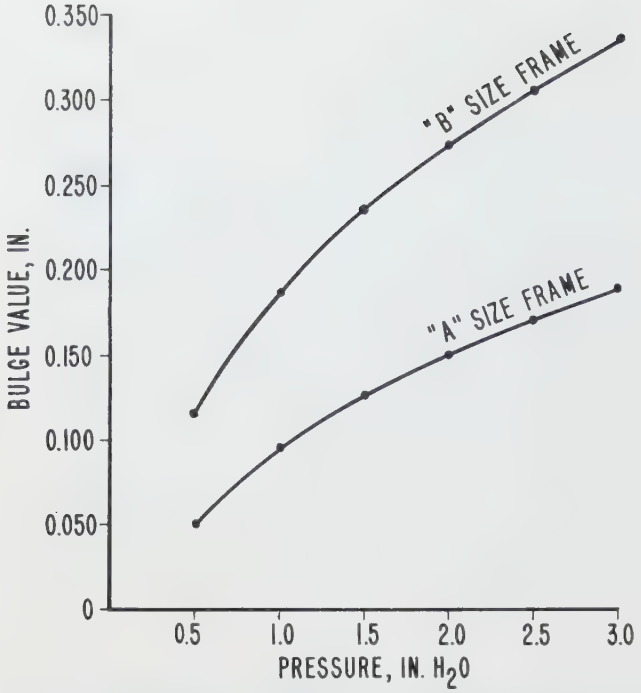


Fig. 2. Effect of carton size and product pressure on bulge value when the board weight is constant. (0.030 in. WPC board at 111 lb./1000 sq. ft.)

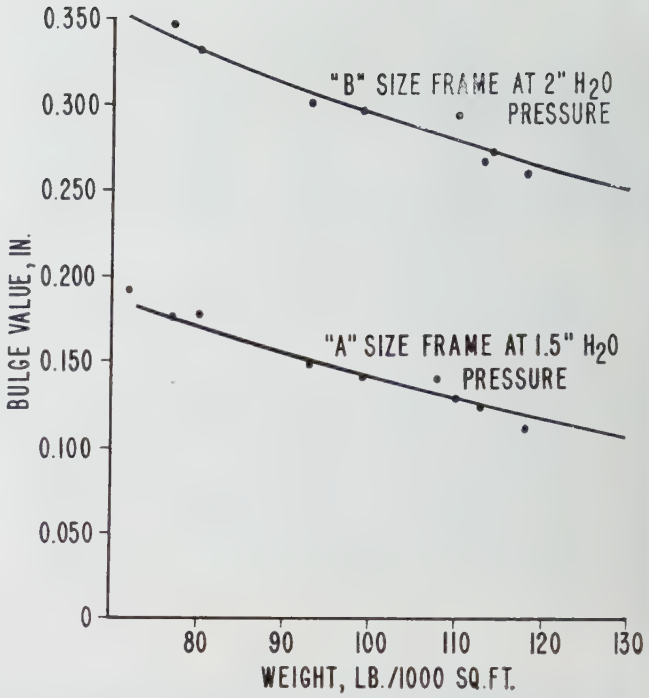


Fig. 3. Effect of board weight on bulge value

from the face of the carton and then using the largest opening that would hold the sample in place on the Bulgemeter and give reproducible results. This gave the following frame opening sizes for the two cartons mentioned above:

"A" $7^5/_{16}$ by $5^3/_8$ in.
"B" $10^3/_8$ by $7^5/_8$ in.

The pressure was calculated by using the formula:

$$P = \frac{WH}{1.156V}$$

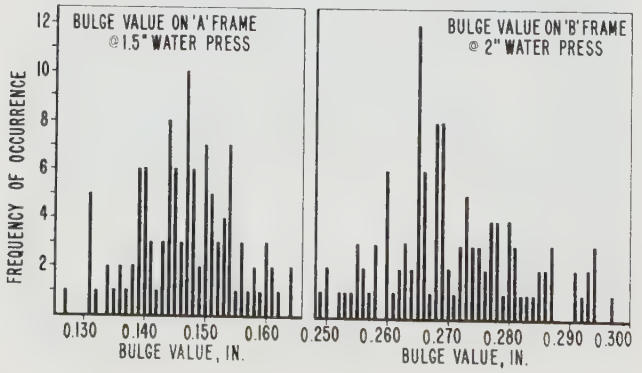
where

P = pressure, in. H_2O
W = packed weight of product, oz.
H = height of carton face, in.
V = volume of carton, cu. in.

Using this formula, carton "A," carrying 22 oz. of product, has approximately $1^1/_2$ in. H_2O pressure exerted against the center of the carton face; carton "B," carrying 54 oz. of product, has approximately 2 in. H_2O pressure.

Samples of white patent coated (WPC) newsback boards with weights from 72 to 118 lb. per 1000 sq. ft. were conditioned at 73°F. and 50% R.H. and tested in these frame sizes at these pressures. The results are shown in Fig. 3, where bulge value has been plotted versus board weight. The curves indicate the path that bulge value takes for the specified frame size and pressure as the board weight changes. When a board has a bulge value measured at the indicated frame size and pressure which, when plotted, does not fall on the established curve, the bulge value for that board will change as the board weight is changed on a line parallel to the established curve that passes through the plotted point.

Samples of cartons being used satisfactorily in the



Figs. 4 and 5. Bulge value distribution

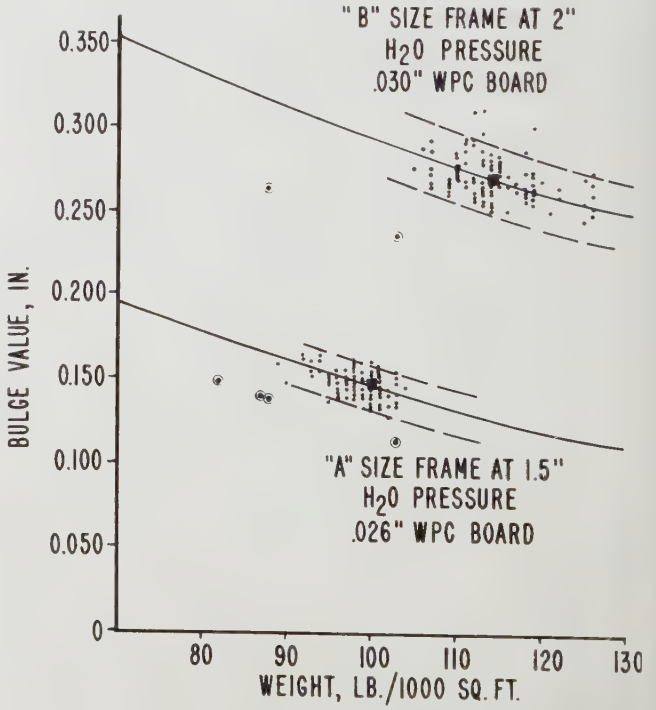
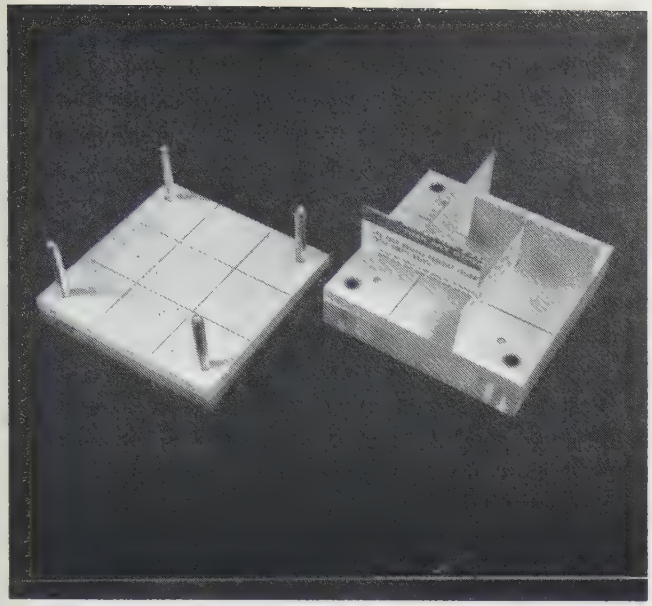
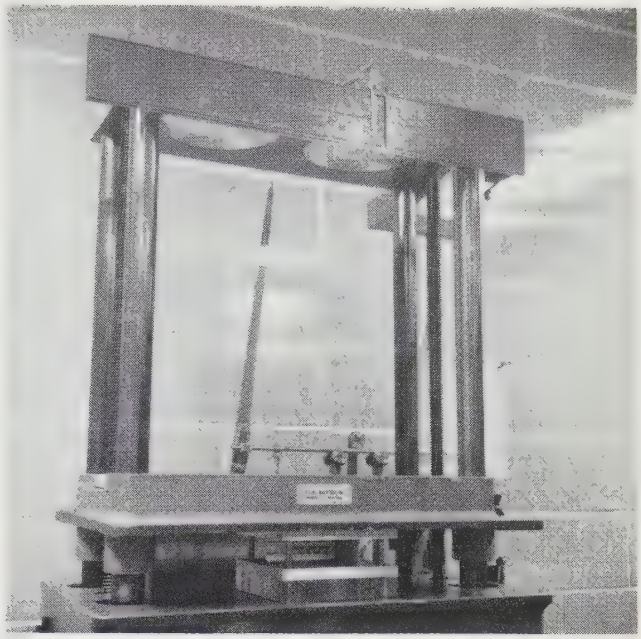
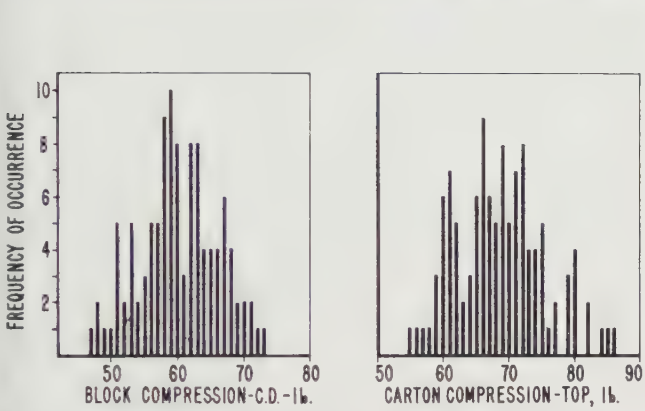


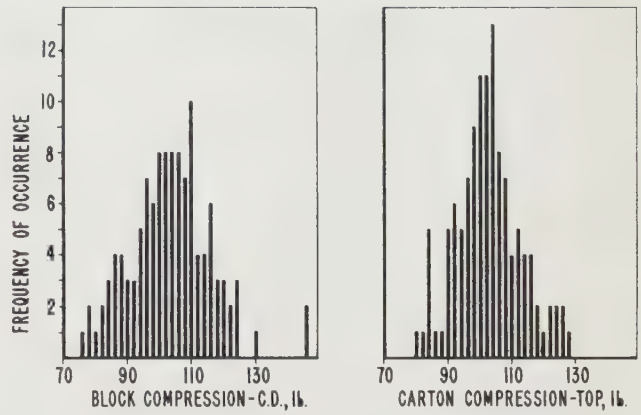
Fig. 6. Effect of board weight on bulge value (regular and experimental boards)





Figs. 7 and 8. The block compression test





Figs. 9 and 10. Block compression and carton compression distribution for cartons A & B

Carton A Carton B

trade were conditioned and tested for bulge value. Each test was reported as the average value for 10 cartons. The results of more than 100 sets of samples in each of the above sizes from eight board mills have been plotted on frequency charts (Figs. 4 and 5). These charts illustrate the variations in bulge value that occur when similar boards are made to the same weight and caliper specifications. The same data was plotted on a graph similar to Fig. 3, to make Fig. 6. Dotted lines have been drawn parallel to the established curves through the plotted values for the bulge value of the weaker and the stronger boards. Figure 6 shows that the weaker boards in the "B" size should have been made with a weight of 128 lb. per 1000 sq. ft. to have a bulge value equal to the average of all the boards tested, and the stronger boards could have been made with a weight of 102 lb. per 1000 sq. ft. to have the same strength. The bulge values for experimental boards have also been plotted on Fig. 6 and are represented by the circles. A line drawn through one of these points parallel to the established curve can be used to predict the weight that board should have to give a desired bulge value. This technique can be used by the board maker, the carton maker, and the carton user.

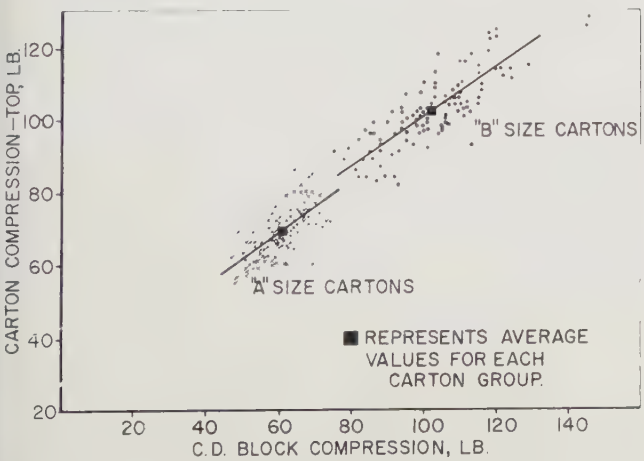


Fig. 11. Relationship of carton compression to block compression (WPC cylinder board)

These cartons must also resist crushing to take their share of the load in the warehouse stack and to look their best at the point of sale. Crush resistance can be measured on a compression tester, and is influenced by the characteristics of the board and by some of the operations in carton making such as scoring and gluing. It is a simple, useful test to make on finished cartons, but it, too, would be awkward to use at the board mill.

This led to the development of the block compression test which consists of cutting samples of board to exact size and measuring their crush resistance, as illustrated in Figs. 7 and 8.

Compression resistance tests were run on the same sets of samples that were used for determining bulge value.

Formed cartons were crushed from top to bottom. The block compression samples were cut and tested so that the grain of the board was crushed in the same direction as in the formed carton; these results were called C. D. block compression.

The results of the carton compression tests and the C. D. block compression tests are shown on frequency charts (Figs. 9 and 10). The relationship of carton compression to block compression is shown in Fig. 11. Some of the variation in carton compression at a given block compression is thought to be due to variations in carton making and could be the subject for further study by a carton maker.

A board with a good bulge value generally has a good compression resistance too; however, it has been found that both must be specified when these characteristics are important in the finished carton.

SUMMARY

Strength specifications make it possible to tailor-make boards and finished cartons to meet specific requirements. There appears to be room for improvement in the use of existing material and manufacturing methods. It is possible that strength specifications can encourage the development of boards that would be uneconomical under weight and caliper restrictions.

Received March 17, 1961.

Kinetics of the Thermal Degradation of Cellulose Nitrate as Measured by an Improved Taliani Procedure

MERRILL A. MILLETT, RAYMOND M. SEBORG, LAWRENCE L. ZOCH, and FRANK J. MASUELLI

By incorporating strain-gage pressure transducers as sensing elements for evolved decomposition gases and appropriately modifying accessory equipment, the Taliani procedure for determination of nitrate stability was placed on a convenient and reproducible basis for either research or routine control use. Direct comparison of the three currently used stability methods (134.5°C. heat test, Bergmann-Junk, and Taliani) showed the Taliani to be least influenced by nitrate processing variables and to provide the best quantitative picture of the course of the thermal degradation process. Data are given on the kinetics of thermal decomposition over the temperature range of 90° to 140°C. On the basis of the straight-line Arrhenius-type plots obtained, it was concluded that nitrate decomposition at normal storage conditions can be predicted with reasonable confidence from data obtained at elevated temperatures. With air as the confining gas during decomposition, the calculated activation energies are essentially independent of the general level of nitrate stability and average 30.7 kcal./mole. With nitrogen as the confining gas, the apparent activation energy increases with increasing nitrate stability. Nitrates at the stability plateau yield an average activation energy of 37.6 kcal./mole. On the basis of the data obtained, a tentative specification for the Taliani procedure was suggested.

A HIGH resistance to spontaneous degradation is one of the essential attributes of a cellulose nitrate designated for military use. Safety in storage and transportation, in processing into propellant formulations, and in the loading of such formulation into end-use items, and retention of specific ballistic properties during prolonged storage, are all critically dependent upon this resistance to degradation or "stability" as it is more commonly called.

MERRILL A. MILLETT, Chemist, RAYMOND M. SEBORG, Chemist, and LAWRENCE L. ZOCH, Chemist, Forest Products Laboratory, Maintained at Madison, Wis., in cooperation with the University of Wisconsin, Forest Service U. S. Department of Agriculture. FRANK J. MASUELLI, Chemist, Propellants Research Section, Feltman Research Laboratories Picatinny Arsenal, Dover, N. J.

Subsequent to the pioneering work of Abel on the potassium iodide–starch test, in 1867, many dozens of procedures and their modifications for evaluating nitrate stability have appeared in the literature (*1*). Of these, only three are in current use in the United States. All three are operated at elevated temperatures and are based on some property exhibited by the gaseous products of decomposition. The 134.5°C. heat test measures the time required to decolorize a strip of 0.1*N* methyl violet paper (*2*). The Bergmann-Junk test measures the total quantity of acidic gases evolved during a 2-hr. heating period at 132°C. (*3*). The Taliani test measures the rate of development of total gas pressure, usually at 110°C. (*4*). Only the 134.5°C. heat has achieved full specification status for nitrocellulose.

As presently used, the three stability procedures serve purely as acceptance criteria providing an empirical base on which to judge whether a given production of cellulose nitrate has or has not attained an arbitrary level of thermal stability. To the authors' knowledge, no exact correlation has as yet been made between these accelerated tests on the nitrocellulose and the long-term storage stability of either the nitrocellulose or of the derived nitrocellulose propellant.

This paper describes the development of an improved Taliani procedure for the routine evaluation of nitrate stability and the application of this procedure to a study of the kinetics of the thermal degradation process under a variety of conditions.

EQUIPMENT

As originally devised by Taliani (*5*), and as modified by more recent workers in the field of propellant evaluation (*4, 6*), the Taliani test employs a manually operated mercury manometer to follow the rate of pressure rise. This places a serious limitation on the usefulness of the

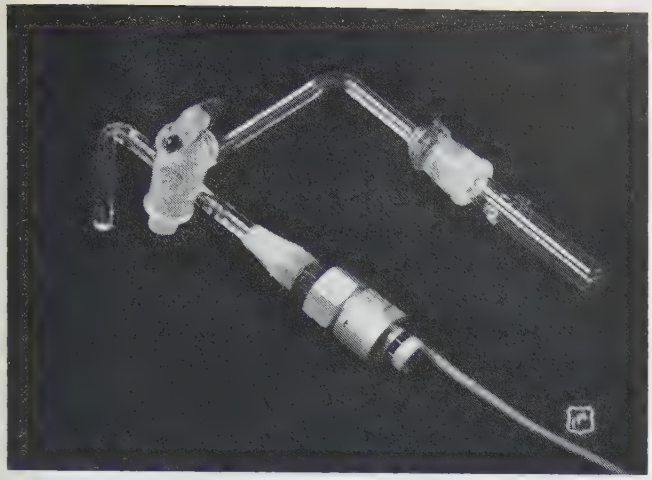


Fig. 1. Taliani stability test assembly

Lead from pressure transducer connects to recording potentiometer.

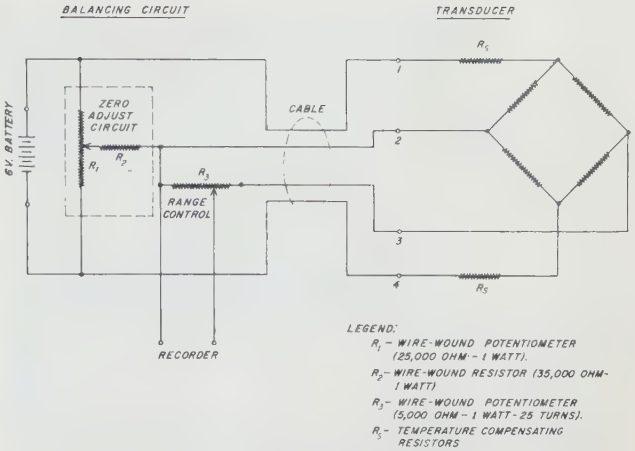

BALANCING CIRCUIT
TRANSDUCER
6 V. BATTERY
ZERO ADJUST CIRCUIT
CABLE
RANGE CONTROL
RECORDER
LEGEND:
R_1 – WIRE-WOUND POTENTIOMETER (25,000 OHM – 1 WATT).
R_2 – WIRE-WOUND RESISTOR (35,000 OHM – 1 WATT)
R_3 – WIRE-WOUND POTENTIOMETER (5,000 OHM – 1 WATT – 25 TURNS).
R_5 – TEMPERATURE COMPENSATING RESISTORS

Fig. 2. Diagram of electrical circuitry of Taliani equipment

procedure, whether for routine control work or for research purposes where the generation of a large number of accurate data points is essential. Operator attention, chances for operator error, and unit test costs are all excessively high. The suggested use of direct-reading pressure gages offers a partial solution (*7*); however, application of modern, sensitive, strain-gage pressure transducers would appear to provide the most satisfactory answer and was the approach taken in this work.

Basically, each Taliani test unit (Fig. 1) consists of a pressure transducer directly connected through a nylon compression fitting and a three-way capillary stopcock to a glass reaction bulb containing 1 g. of the cellulose nitrate under investigation. Immersion of the reaction bulb int a thermostatted bath at an elevated temperature initiates the stability experiment. As thermal degradation proceeds, the pressure of the evolved gases is transmitted from the reaction bulb to the transducer diaphragm through a capillary tube filled with silicone oil. The oil serves to protect the metal diaphragm from direct contact with the corrosive gases as well as to reduce the nonreaction-zone volume of the equipment. The output of the transducer is fed to a recording potentiometer.

Pressure Transducers

The strain-gage pressure transducers used in this study were obtained from Statham Instruments, Inc., 12401 West Olympic Boulevard, Los Angeles 64, Calif. They were designated as Model PM 131TC ±5–350, and operate over a range of ±5 p.s.i. differential. The units are temperature compensated from −65 to 250°F. Electrical output is ±10 mv. full scale on open circuit at 5 v. excitation. Connection to the output terminals of the transducers is made by means of DC5 disconnect assemblies from which four-conductor wires lead to a balancing circuit, and thence to a multipoint strip-chart recording potentiometer having a range of 0 to 10 mv. Figure 2 is a diagram of the electrical system used for each transducer unit. Figure 3 shows five assembled systems and the recording potentiometer. For the present study, four 1.5-v. dry cells connected in series constituted the power source for each unit. For routine use, however, it would be advantageous to use a stable line-operated power supply as a common current source.

Reaction Tubes and Accessory Glassware

Construction and operation of the Taliani equipment are most readily visualized by reference to Fig. 1. The reaction bulb is constructed by sealing off the tube end of a TS 14-20 male ground-glass joint to provide an overall length of approximately 8 cm. The inside diameter of a joint of this type is 10 mm. The female portion of the joint is close-coupled to the central leg of a 1-mm. bore, three-way capillary stopcock. This capillary leg is bent as shown, having an outgoing length (from the stopcock) of about 8 cm. and a downward length (to the reaction bulb) of about 4 cm. This arrangement permits the reaction bulb to be completely immersed in the bath while the stopcock and pressure transducer are external to the bath. Maintenance of an adequate closure of the ground-glass joint is provided by a metal spring (not shown) stretched over the glass hooks projecting from the two parts of the joint.

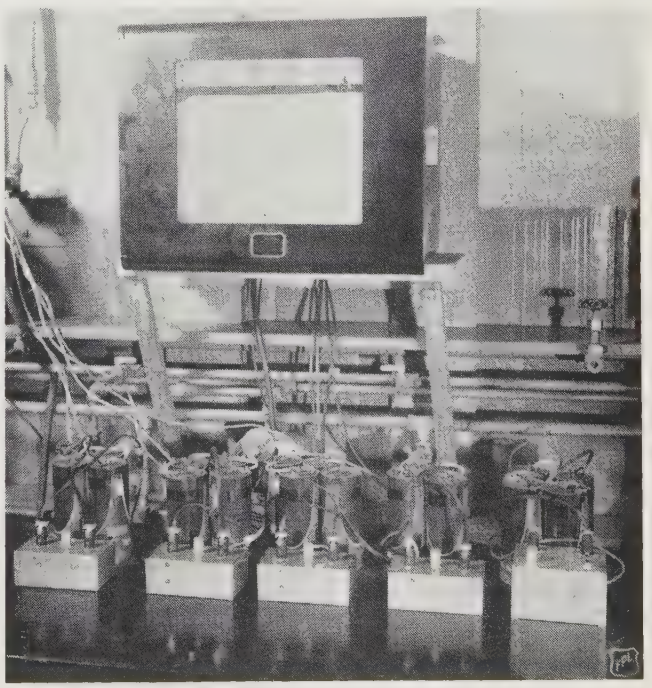


Fig. 3. Power supply and recording equipment

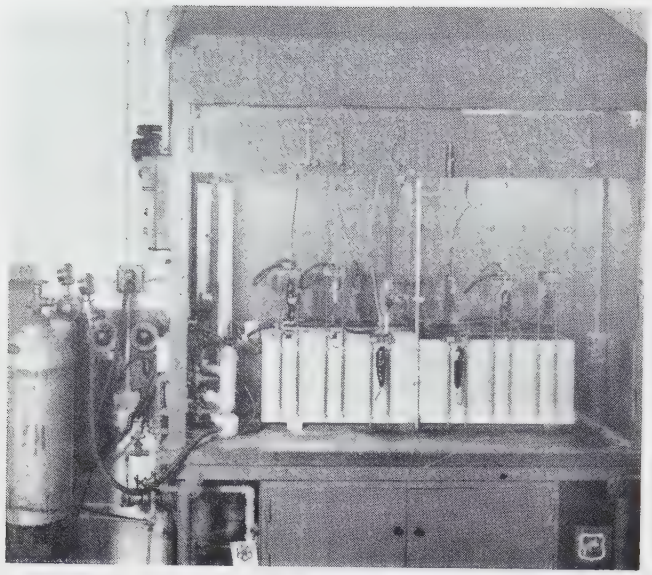


Fig. 4. Overall view of Taliani assembly

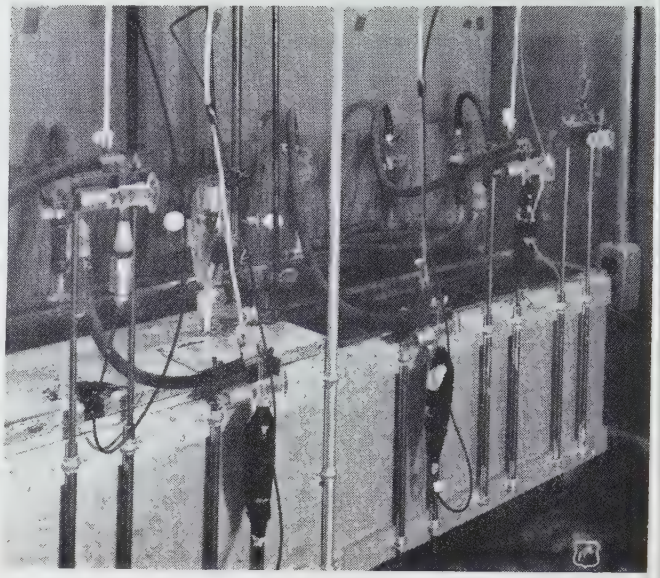


Fig. 5. Closeup of Taliani bath showing evacuation manifold, manner of insulating transducers, and equipment for raising and lowering reaction bulbs

The upper leg of the stopcock is used for evacuation, admission of dry nitrogen or air, and venting, and may be of any convenient length. The lower leg, about 4 cm. in length, projects into a nylon compression fitting made for $^1/_4$-in. outside-diameter tubing. This nylon fitting is attached to one end of a doubly threaded connector, machined from a brass rod having a 1.5-mm. axial hole. The connector is in turn seated in the threaded hole of a Statham A8T2 pressure adapter attached to the transducer.

Five test units were constructed in this manner. All were adjusted and calibrated to a fixed volume. This was accomplished by carefully expanding or contracting the closed ends of the reaction bulbs to obtain an overall reaction-zone volume (bulb plus capillary tubing to stopcock) of 7.30 ± 0.05 cc. Mercury was used as the calibrating liquid. Two matching sample bulbs were prepared for each test unit. Prior to use, all ground-glass surfaces were lapped with No. 400 grit grinding compound. This assured an adequate mating of the joints and minimized leaks. All joints were lightly lubricated with a high-vacuum silicone grease.

Constant Temperature Bath and Sample Bulb Immersion Assembly

The constant temperature bath (Figs. 4 and 5) consists of a rectangular wooden box 41 in. long, 6 in. wide, and 9 in. deep, made from $^3/_4$-in. lumber and lined with 22-gage copper sheeting. All joints are soldered. The bath is provided with a copper false bottom that rests on corner supports 2 in. above the bottom of the bath. This false bottom fits snugly to the side near the center of the bath and gradually tapers to a clearance of about 1 in. at the ends of the bath. A $3^3/_4$-in. hole is cut in the center of the false bottom below which paddle stirrer is positioned. The stirrer is driven by an air motor turning at approximately 700 r.p.m. The bath is filled with glycerine and covered with two sections of $^5/_8$-in. plywood wrapped in aluminum foil. Holes of appropriate size are drilled in the covers to permit entry of the sample bulbs and the necessary control units.

Heat for the bath is supplied by four 450-w. immersion heaters—one located at each corner of the bath beneath the false bottom. The heaters in opposite corners are paired. One pair is operated at a constant heat insufficient to maintain the bath at the desired temperature. The other pair is used intermittently at either a high or low heat under control of a mercury thermoregulator. Variable transformers control the heat output of each pair of heating elements. With the covers in place, temperature is within 0.1°C. of the set point at all locations within the bath, and can be maintained within ±0.02°C. at any given location.

Warning of an excessive rise in bath temperature due to failure of the mercury regulator is provided by a bimetallic regulator mounted in one corner of the bath. This regulator is adjusted to make contact and actuate a warning bell at 2 to 3°C. rise in bath temperature above the set point of the mercury regulator. For protection of the operator against explosion hazards, the entire Taliani equipment is mounted in a hood having safety-glass doors covering the front opening. The doors have been removed for these photographs.

As illustrated, each test assembly is clamped between the halves of a split wooden block bearing two lengths of $^1/_4$- by 10-in. brass rod. Wing nuts on the upper threaded ends of these rods provide the necessary clamping pressure, and also permit disassembly for cleaning. The rods project into 10-in. lengths of brass tubing fastened to the sides of the heating bath, thus assuring adequate support and guidance. The entire test assembly may be raised from or lowered into the bath from outside the safety-glass doors by means of the cord-and-pulley arrangement shown.

Mounted on a section of plywood in the background of the photographs is a manifold used for the evacuation and replacement of air by nitrogen in the sample bulbs. It is constructed of rubber pressure tubing and glass tees—one for each Taliani unit. The stopcocks permit one or all of the sample bulbs to be connected to the manifold at one time. Vacuum is supplied by a mechanical pump connected to one end of a glass Y-tube

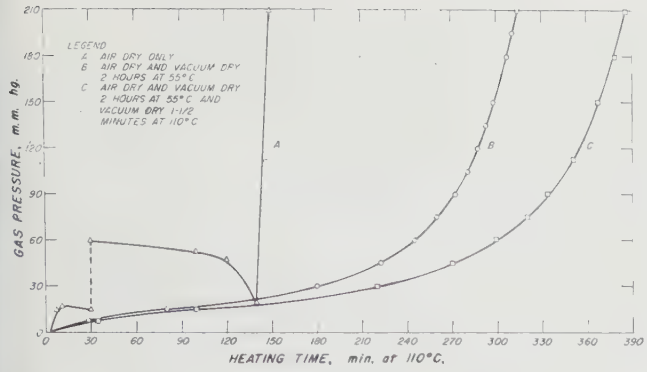

LEGEND
A AIR DRY ONLY
B AIR DRY AND VACUUM DRY 2 HOURS AT 55°C
C AIR DRY AND VACUUM DRY 2 HOURS AT 55°C AND VACUUM DRY 1-1/2 MINUTES AT 110°C
GAS PRESSURE, m.m. hg.
HEATING TIME, min. at 110°C.

Fig. 6. Influence of sample drying conditions on rate of pressure rise

joining the manifold. Return air or tank nitrogen is passed through a drying tower packed with calcium chloride prior to entering the other end of the Y-tube. To prevent sample loss due to the sudden inrush or exit of confining gases, a short section of capillary tubing is inserted between the Y-tube and the manifold.

EXPERIMENTAL

Sample Material. The nitrocellulose samples used during the course of this study originated in composite lots of raw (unstabilized) cellulose nitrate taken from commercial production of Badger Ordnance Works, Baraboo, Wis. Both the 12.6% (pyrocellulose) and 13.4% (guncotton) nitrogen levels were represented. The composites were thoroughly blended by slurrying in distilled water and then washed on a filter to remove all loosely held nitrating acid. The water-wet material was stored in polyethylene bags at 40°F. until used.

Portions of these composite blends were stabilized to varying degrees at 100°C. Acid-boil times of 10, 20, 40, 80, and 120 hr. were used at the 13.4% nitrogen level, and acid-boil times of 6, 12, 24, 48, and 72 hr. were used at the 12.6% nitrogen level. Two samples were prepared at each acid-boil time—one sample being processed in distilled water solutions and one sample being processed in solutions made up with water from the Badger Ordnance Works (hard water). Processing was accomplished by the techniques developed in earlier work at the Forest Products Laboratory (*8*). These 20 samples encompass most types of nitrocellulose likely to be encountered in stability determinations and provide a good basis on which to evaluate the performance of a test method.

Table I. Influence of Sample Drying Conditions on the Rate of Gas Evolution in the Taliani Test at 110°C.

Dry conditions	*Heating time to yield 200 Hg/mm. gas pressure, min.*
Airdry at 30% R.H.	130
	150
	128
Average	136
Airdry plus 2 hr. vacuum dry at 50°C.	322
	328
	311
Average	320
Airdry plus 2 hr vacuum dry at 50°C. plus 1½ min. vacuum dry at 110°C.	378
	379
	395
	384
	383
	375
Average	382

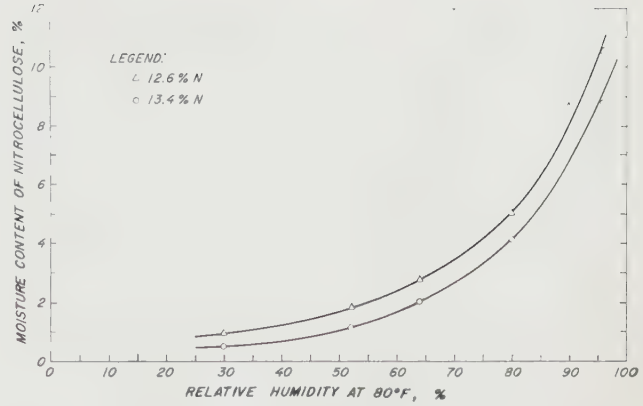


Fig. 7. Moisture content–relative humidity curves for fibrous cellulose nitrates at the 12.6 and 13.4% nitrogen levels

Sample Preparation. Goujon in his early work had reported that moisture exerted a considerable influence on the results of the Taliani test (*9*). As a consequence, it was necessary to establish a suitable drying schedule for the nitrate samples to be used in the present study. Three different procedures were evaluated. (1) air-drying to moisture equilibrium at 30% R.H., (2) air-drying as in (1) followed by vacuum drying for 2 hr. at 50°C. in the tared reaction bulbs, and (3) air and vacuum-drying as in (2) followed by a further vacuum-drying in the heating bath while the sample is attaining temperature equilibrium. Three replications were made for procedures 1 and 2, and six for procedure 3, using a sample of 13.4% nitrogen content and a bath temperature of 110°C. The results are listed in Table I and typical curves plotted in Figure 6.

The most striking effect is that shown by the air-dried samples (curve A) having a moisture content of approximately 0.6%. Following a rapid initial rise to about 15 mm., gas pressure decreased at a slow but constant rate for approximately 105 min., and then decreased at a greatly accelerated rate for the next 30 minutes. To prevent possible damage to the transducer from excessive negative pressure, air was added to the sample bulb as indicated by the vertical dotted line and heating continued. No change in the rate of pressure decrease is evident from this addition of air. At the point of minimum pressure, there was an abrupt change in the nature of the reaction, and gas was evolved at an extremely rapid rate with attendant pressure rise. Using a pressure of 200 mm. of mercury as an end point, the test was completed in an average heating time of 136 min.

Drying as in procedure 2 resulted in pressure–time curves of the type illustrated by curve B; an initial induction period of slow pressure rise followed by a change to a fast but essentially constant rate of rise. The average time to reach the 200-mm. end point was 320 min.

Drying as in procedure 3 resulted in an extension of the induction period, but had no apparent effect on the rate of the principal thermal decomposition reaction (curve C). Average time for attaining the 200-mm. pressure end point was 382 min.

Acting on the possibility that the final vacuum-drying at bath temperature might prove sufficient, we performed a comparative experiment in which one group of samples was dried as in procedure 3, and a

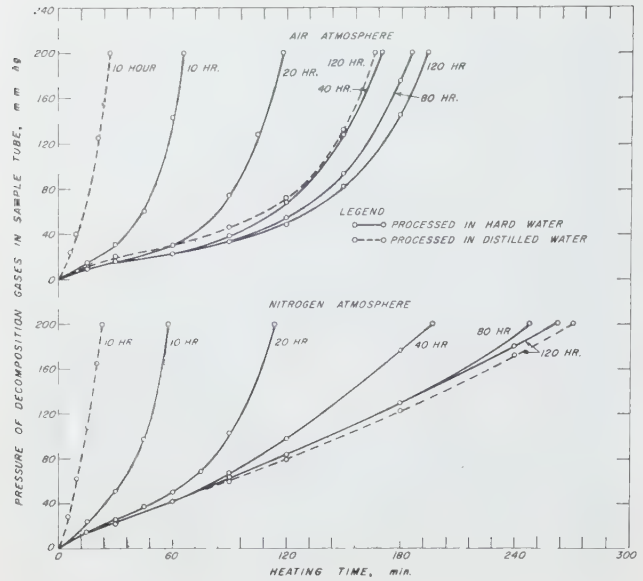


Fig. 8. Typical pressure versus heating-time curves showing influence of acid-boil time, processing water, and confining gas on the decomposition of cellulose nitrate at 120°C.—13.4% nitrogen level

matching group of samples was given only the 3-min. vacuum drying in the reaction bulb at bath temperature. In all cases, drying procedure 3 gave higher heating times and a uniformly higher level of reproducibility.

On the basis of these findings, procedure 3 was selected as the standard drying schedule for all subsequent test work, and would be the the recommended schedule should the Taliani test be given consideration as a specification test for nitrate stability. No significant increase in operator effort is required since the final vacuum-drying is done while the sample is coming to temperature equilibrium in the bath. The same procedure is applicable whether air or nitrogen is to be used as the confining gas during the test.

Assembly and Calibration of Test Units. As mentioned earlier, each of the Taliani units was adjusted to an overall reaction-zone volume of 7.30 ± 0.05 cc. using mercury as the calibrating medium. This volume comprised the reaction bulb and the length of capillary tubing leading from the bulb to the stopcock (Fig. 1). The capillary tubing leading from the stopcock to the transducer, and the free space within the transducer and its accessory fittings are filled with a silicone oil [General Electric SF96 (100)]. The filling is accomplished by placing the entire assembly in a vacuum desiccator with the stopcock turned so that the transducer is vented through the short, bent section of capillary tubing. The end of this tubing projects into a reservoir of the silicone oil. Following thorough evacuation, the oil is forced into the transducer chamber and tubing by slowly readmitting air to the desiccator. Excess oil in the vent tube and in the base of the stopcock is removed. To prevent pressure fluctuations due to air currents during a run, the entire transducer and accessory fittings are wrapped with fiberglass insulation and covered with aluminum foil, as illustrated in Fig. 5.

Each Taliani unit is calibrated over the pressure range of 0 to 200 mm. of mercury, using dry air as the pressuring medium and a mercury manometer in parallel with the transducer. By means of the trimming potentiometer (R_3 of Fig. 2), it is possible to adjust the recorder print-out to exactly 200 on the chart scale. Zero adjustment is made by means of trimming potentiometer R_1. When similar samples are being run, it is convenient to set the inidividual R_1's so that the zero points fall at 5-mm. scale intervals apart from each other. This provides a visual separation of the pressure–time curves.

Table II. Taliani Data for Samples of 13.4% Nitrogen (Pressure End Points)

Test temperature, °C.	Acid-boil time, hr.	Heating time to 200 mm. Hg.,[a] min.				Heating time to 100 mm. Hg.,[a] min.			
		Air atmosphere		Nitrogen atmosphere		Air atmosphere		Nitrogen atmosphere	
		Hard water	Distilled water	Hard water	Distilled water	Hard water	Distilled water	Hard water	Distilled water
90	10	2032	659	[b]	...	1908	542	[b]	...
	20	3032	1215	...	...	2897	1088	...	...
	40	3616	2374	...	...	3478	2238	...	...
	80	3404	3024	...	...	3269	2875	...	...
	120	3600	2847	...	...	3486	2707	...	...
100	10	575	198	528	185	512	145	439	128
	20	1036	325	1056	384	962	256	878	271
	40	1257	805	[b]	...	1177	724	[b]	...
	80	1280	1123	...	...	1187	1042	...	...
	120	1374	1053	...	...	1297	974	...	...
110	10	194	71	181	72	168	47	142	49
	20	342	132	351	152	306	98	281	103
	40	468	325	650	518	421	279	421	335
	80	486	413	882	898	442	370	495	531
	120	489	425	906	960	448	381	506	540
120	10	68	30	62	25	56	19.5	50	17.5
	20	121	52	115	51	101	36	90	34
	40	174	129	198	155	144	101	122	100
	80	187	173	247	254	157	142	137	140
	120	197	170	253	272	166	142	135	147
130	10	26	12.2	24	12.1	21.0	8.5	19.0	7.8
	20	44	22.0	41	21.1	35	15.0	30	14.3
	40	67	51	67	56	49	35	40	33
	80	75	69	79	79	56	50	44	43
	120	77	69	78	82	57	50	43	42
140	10	...	...	[b]	...	...	...	...	...
	20	16.6	...	15.6	...	12.5	...	11.6	...
	40	24.5	20.1	22.3	20.0	16.2	12.9	13.9	12.4
	80	27.1	26.1	25.2	25.0	17.4	16.2	14.3	14.4
	120	27.8	26.0	24.1	25.6	17.7	16.0	13.7	14.3

[a] Includes 2 min. of the 4-min. temperature equilibration period.
[b] Not run because of hazard or excessive time.

Procedure

The experimental procedure developed for the measurement of thermal degradation with the modified Taliani equipment may be outlined as follows:

1. Airdry sufficient water-wet nitrate sample to accommodate two runs. Overnight drying of the sample thinly spread on an aluminum foil tray is generally sufficient for attainment of moisture equilibrium with the prevailing atmosphere.

2. Weigh (to the nearest milligram) sufficient air-dry nitrocellulose into each of two tared reaction bulbs to provide an ovendry sample weight of 1 g. Dry 2 hr. at 50 to 55°C. in a vacuum oven. Cool samples in a desiccator. To provide a relatively uniform packing density, the nitrocellulose is lightly tamped with a section of wooden dowel four or five times during the course of the loading operation.

Moisture content, which is a function of the prevailing relative humidity, may be obtained with sufficient accuracy by reference to the moisture content-relative humidity curves shown in Fig. 7.

3. Attach sample bulbs to Taliani equipment and evacuate bulbs for approximately 2 min. while the test assemblies are suspended in the air above the thermostatted bath. Use of the manifold will permit all assemblies to be evacuated simultaneously. For runs in a nitrogen atmosphere, alternate evacuation and flushing with nitrogen gas would comprise this step.

4. Immerse sample bulbs into the bath by means of the rope-and-pulley systems and continue evacuation for exactly 3 min.

5. Readmit dry air or nitrogen to the reaction bulbs over a 1-min. period to restore atmospheric pressure, then adjust stopcocks so as to connect reaction bulbs to the transducers.

6. Continue heating until decomposition gas pressure attains the desired end point on the recorder chart, at which point raise the test assembly from the bath and leave it suspended in the air. As the pressure drops toward zero on cooling, turn the stopcock so as to vent both sample bulb and transducer to the atmosphere.

7. After rechecking transducer calibration, determine from the recorder chart the total heating time required for each nitrate sample to attain the given pressure end point. Correct these times for changes in barometric pressure that may have occurred during prolonged heating periods. Add an additional 2 min. to each value so obtained to account for the fact that the samples were at bath temperature and undergoing decomposition for about one half of the final drying period.

Variables

In most work on evaluating the stability of double-base propellants, a decomposition temperature of 110°C. has been used (*4*, *6*, *7*). Nitrogen has commonly been specified as the confining gas in contact with the sample at the beginning of the test, although a recent study has shown that oxygen may provide a more sensitive measure of the residual safe life of propellants (*6*). Gas pressures of 100 or 200 mm. of mercury have generally been used as test end points.

Because of the increased sensitivity and ease of operation of the transducer equipped Taliani units, and because the present study was concerned exclusively with cellulose nitrate, it was considered desirable to broaden the range of the test variables as far as practical, and thereby gain a better understanding of the degradation process. To this end, data were obtained at 10°C. intervals over the temperature range of 90° to 140°C., using both air and nitrogen as confining gases. In addition to the arbitrary 100- and 200-mm. pressure end points, data were also recorded as to the heating times required to produce 0.50 and 1.00 cc.

Table III. Taliani Data for Samples of 13.4% Nitrogen (Volume End Points)

Test temperature, °C.	Acid-boil hr. time, hr.	Heating time to produce 1.00 cc. gas[a] min.				Heating time to produce 0.50 cc. gas,[a] min.			
		Air atmosphere		Nitrogen atmosphere		Air atmosphere		Nitrogen atmosphere	
		Hard water	Distilled water	Hard water	Distilled water	Hard water	Distilled water	Hard water	Distilled water
90	10	1989	622	[b]	...	1841	482	[b]	...
	20	2985	1172	...	...	2826	1016	...	...
	40	3567	2327	...	...	3410	2171	...	...
	80	3355	2969	...	...	3205	2805	...	...
	120	3569	2796	...	...	3425	2643	...	...
100	10	553	180	495	163	485	123	400	113
	20	1013	301	984	339	932	230	822	239
	40	1231	778	[b]	...	1146	690	[b]	...
	80	1244	1096	...	...	1150	1008	...	...
	120	1348	1027	...	...	1266	942	...	...
110	10	186	63	165	64	158	40	129	43
	20	331	122	325	135	294	87	252	86
	40	454	311	567	449	404	262	364	293
	80	473	399	739	776	426	354	405	434
	120	477	411	763	811	432	357	405	437
120	10	64	26	58	22.5	53	17.5	43	15.5
	20	116	47	106	45	95	32	82	30
	40	166	122	172	139	134	91	106	88
	80	179	166	209	215	145	132	114	117
	120	188	164	212	231	154	130	112	122
130	10	24	11.0	23.0	10.8	20.0	7.5	17.8	7.0
	20	41	20.0	37	19.0	32	13.5	28	12.5
	40	61	47	59	49	44	31	36	29
	80	70	64	65	67	50	44	35	37
	120	72	64	67	70	52	44	37	37
140	10	...	[b]	...	...	...	...	...	...
	20	15.6	...	14.6	...	11.8	...	10.7	...
	40	22.3	18.4	20.1	18.2	14.8	11.6	12.5	11.2
	80	24.9	23.8	21.8	22.0	15.7	14.5	12.8	12.5
	120	25.4	23.3	21.2	22.5	15.9	14.3	12.1	12.5

[a] Includes 2 min. of the 4-min. temperature equilibration period.
[b] Not run because of hazard or excessive time.

of decomposition gases at standard temperature and pressure.

To insure a more meaningful estimate of the precision of the Taliani method, all 20 nitrate samples were run random sequence by each of two operators at each test condition.

RESULTS

Thermal Degradation Data

Figure 8 shows a set of pressure versus heating-time curves which were typical of all of the samples evaluated. The data points were taken directly from the recording charts for a bath temperature of 120°C. As can be readily seen, nitrate decomposition is strongly influenced by the extent of stabilization treatments (acid-boil time), the type of water used in such treatments, and the nature of the gaseous atmosphere present at the beginning of a test run.

With air as the confining gas, all nitrate samples exhibit decomposition curves of essentially identical form—an induction period followed by an abrupt change to a rapid rate of degradation that is similar for all levels of nitrate stability. The length of the induction period is directly related to acid-boil time or stability level, and is appreciably greater for those samples processed in hard water.

With nitrogen as the confining gas, thermal degradation follows a different course. At short acid-boil times, where retained acid or other catalytic agents still persist, degradation proceeds in much the same manner as in air. As these materials are removed by

Table IV. Taliani Data for Samples of 12.6% Nitrogen (Pressure End Points)

Test temperature, °C.	Acid-boil time, hr.	Heating time to 200 mm. Hg,[a] min. — Air atmosphere — Hard water	Heating time to 200 mm. Hg,[a] min. — Air atmosphere — Distilled water	Heating time to 200 mm. Hg,[a] min. — Nitrogen atmosphere — Hard water	Heating time to 200 mm. Hg,[a] min. — Nitrogen atmosphere — Distilled water	Heating time to 100 mm. Hg,[a] min. — Air atmosphere — Hard water	Heating time to 100 mm. Hg,[a] min. — Air atmosphere — Distilled water	Heating time to 100 mm. Hg,[a] min. — Nitrogen atmosphere — Hard water	Heating time to 100 mm. Hg,[a] min. — Nitrogen atmosphere — Distilled water
100	6	1449	1018	[b]	...	1361	921	[b]	...
	16	1681	1296	...	...	1581	1203	..	...
	32	1786	1478	...	...	1699	1392	..	...
	48	1895	1717	...	...	1806	1634	...	...
	72	1971	1568	...	...	1875	1483	...	...
110	6	572	382	858	642	513	324	572	437
	16	616	481	1076	940	560	424	688	604
	32	678	574	1165	1270	620	517	728	793
	48	696	626	1137	1351	638	572	705	882
	72	655	615	1124	1352	600	560	784	815
120	6	217	157	266	199	180	122	173	132
	16	246	199	316	279	207	164	199	176
	32	263	228	337	351	224	193	205	215
	48	270	253	324	368	230	217	197	218
	72	273	246	322	367	232	208	192	210
130	6	83	62	87	71	63	44	57	45
	16	94	76	98	90	71	56	62	57
	32	98	89	105	106	75	66	64	66
	48	102	95	101	111	77	72	61	66
	72	103	94	100	110	77	70	60	65
140	6	30.3	23.3	29.3	25.4	21.3	15.8	18.9	16.4
	16	33.1	28.6	31.8	30.1	22.6	18.8	19.7	18.6
	32	35.1	32.9	32.4	34.1	23.7	21.5	20.0	20.3
	48	34.8	34.7	32.1	34.3	23.2	23.1	19.5	20.3
	72	35.5	34.0	31.3	33.9	23.7	22.2	19.1	20.3

[a] Includes 2 min. of the 4-min. temperature equilibration period.
[b] Not run because of excessive time.

Table V. Taliani Data for Samples of 12.6% Nitrogen (Volume End Points)

Test temperature, °C.	Acid-boil hr.	Heating time to produce 1.00 cc. gas,[a] min. — Air atmosphere — Hard water	Heating time to produce 1.00 cc. gas,[a] min. — Air atmosphere — Distilled water	Heating time to produce 1.00 cc. gas,[a] min. — Nitrogen atmosphere — Hard water	Heating time to produce 1.00 cc. gas,[a] min. — Nitrogen atmosphere — Distilled water	Heating time to produce 0.50 cc. gas,[a] min. — Air atmosphere — Hard water	Heating time to produce 0.50 cc. gas,[a] min. — Air atmosphere — Distilled water	Heating time to produce 0.50 cc. gas,[a] min. — Nitrogen atmosphere — Hard water	Heating time to produce 0.50 cc. gas,[a] min. — Nitrogen atmosphere — Distilled water
100	6	1423	989	495	163	1316	868	[b]	...
	16	1641	1270	984	339	1537	1154	...	...
	32	1759	1453	[b]	...	1656	1347	...	...
	48	1867	1693	...	...	1764	1594	...	...
	72	1937	1543	...	...	1835	1442	...	...
110	6	555	366	749	567	490	301	508	386
	16	600	464	939	819	537	401	592	528
	32	662	558	1013	1100	598	495	619	663
	48	679	611	990	1169	616	551	596	700
	72	639	600	959	1171	580	538	575	681
120	6	207	148	234	174	167	111	154	115
	16	237	190	276	244	194	152	174	155
	32	254	220	293	306	211	180	177	185
	48	259	246	282	318	215	203	169	185
	72	262	236	277	313	217	194	164	177
130	6	78	57	77	63	59	40	51	38
	16	88	71	87	80	65	50	55	50
	32	93	83	93	96	69	60	54	58
	48	96	90	86	97	71	65	53	57
	72	96	88	88	96	71	64	53	56
140	6	28.1	21.9	26.6	23.4	19.6	14.5	17.2	14.6
	16	30.8	26.3	28.5	27.0	20.8	17.0	17.7	16.7
	32	32.4	30.3	29.3	30.5	21.4	19.4	17.9	17.8
	48	31.6	32.2	28.6	30.5	21.0	20.7	17.4	18.3
	72	32.9	31.5	28.2	30.6	21.4	20.0	17.1	18.0

[a] Includes 2 min. of the 4-min. temperature equilibration period.
[b] Not run because of excessive time.

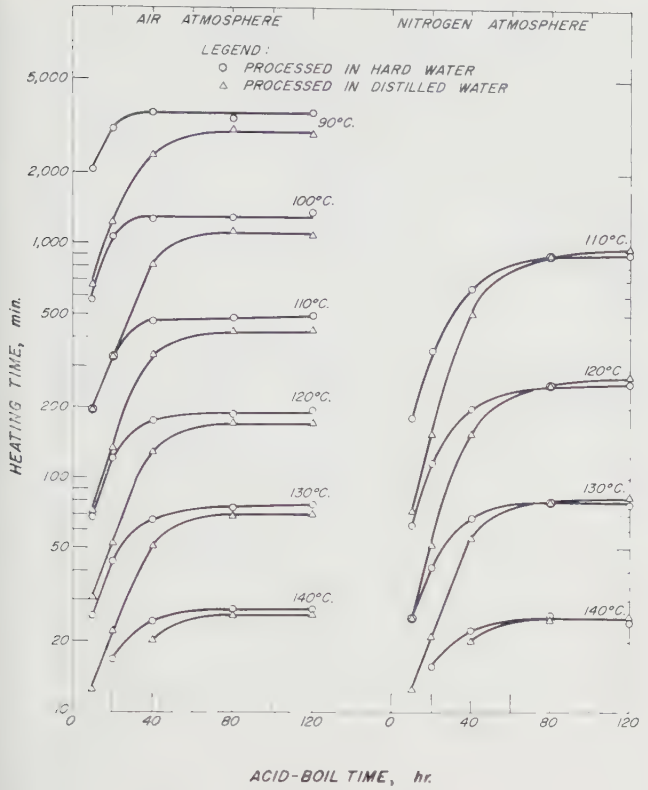


Fig. 9. Influence of temperature, processing water, confining gas, and acid-boil time on the heating time required to produce a decomposition-gas pressure of 200 mm. Hg.—13.4% nitrogen level

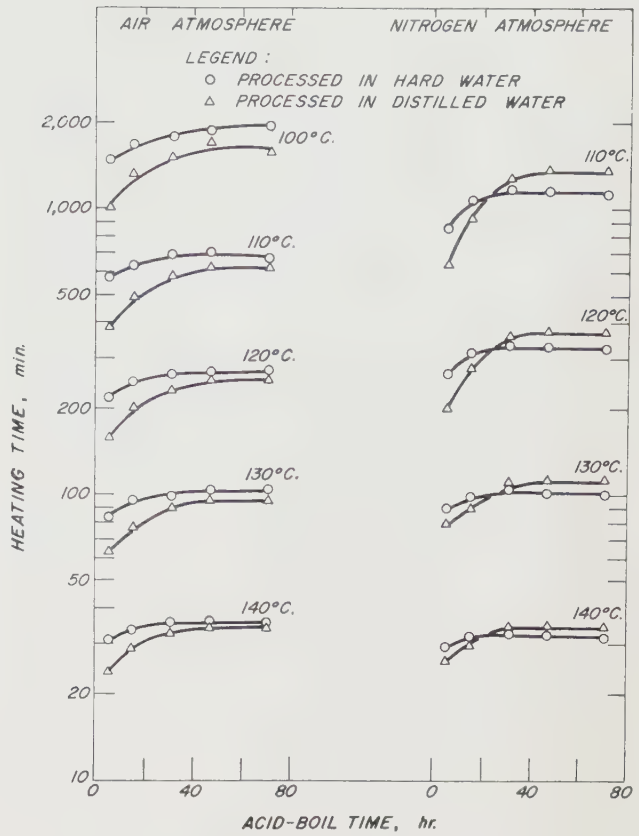


Fig. 10. Influence of temperature, processing water, confining gas, and acid-boil time on the heating time required to produce a decomposition-gas pressure of 200 mm. Hg.—12.6% nitrogen level

increasing stabilization treatment, however, the rate of rapid secondary degradation reaction decreases. With nitrates at the stability plateau, thermal degradation proceeds at a nearly constant rate over the entire heating period. Processing water again has an influence on the course of the reaction, but the extent of its influence is a function of nitrate stability level. At short acid-boil times (low stability), hard water processing retards nitrate decomposition about the same as it did for the tests conducted in air. At the stability plateau, however, distilled water processing appears to provide a somewhat higher ultimate stability.

In order to translate these pressure–time curves on the recording charts into form more suitable for the interpretation of the thermal degradation process, the heating times required for each sample to attain the four end points previously mentioned were determined. Appropriate corrections were made for changes in barometric pressure that occurred during prolonged heating periods and for temperature equilibration time. The resultant data are listed in Tables II and III for samples at the 13.4% nitrogen level, and in Tables IV and V for samples at the 12.6% nitrogen level. The listed values represent the average of the individual results obtained by the two operators. Statistical treatment of the individual data indicate an overall standard deviation of the operator differences, expressed on a percentage basis, of 3.16 for the Taliani procedure.

Nitrate Stabilization

Representative data from Tables II and IV are shown graphically in Figs. 9 and 10. Heating times to produce a decomposition-gas pressure of 200 mm. of mercury are plotted as a function of acid-boil times for nitrate samples at the 13.4 and 12.6% nitrogen levels, respectively. A logarithmic scale is used in order to accommodate the broad range of time intervals.

Taken as a group, these families of curves provide a striking picture of the course of nitrate stabilization. As measured by the relative heating times required to generate the designated gas pressure, nitrate stability is seen to undergo a rapid initial rise with comparatively small increments in acid-boil time. The rate of stabilization then diminishes and ultimately a stability plateau is attained beyond which further processing is without significant effect.

Within a given family of curves, the acid-boil requirements for reaching the plateau are essentially independent of degradation temperature for a given processing water. Temperature, of course, has a strong influence on the rate of attainment of the 200-mm. pressure end point. Graphical inspection of the data in Tables II and V at the other end points has established the fact that test end point as such is without important influence on Taliani results. Acid-boil requirements for attaining the stability plateau are essentially the same at all four end points used in the present study. End point selection for routine use can therefore be based on experimental convenience.

As shown by Tables II to V and Figs. 9 and 10, processing water has a significant effect on both the rate of attainment and the ultimate level of the stability plateau. Previous work has shown the 134.5°C. heat and the Bergmann-Junk test to be similarly influenced (*8*). In the Taliani procedure, however, this processing water effect is also influenced by the nature

Table VI. Comparative Evaluation of Nitrate Stability by the Three Test Methods

Stability method	Stability level	Acid-boil time required to attain indicated stability level, hr. — 13.4% nitrogen content — Distilled water	13.4% nitrogen content — Hard water	12.6% nitrogen content — Distilled water	12.6% nitrogen content — Hard water
134.5°C. heat test	Specification[a]	Not reached	Not reached	Not reached	Not reached
	Plateau	75–85	35–45	55–65	10–20
Bergmann-Junk	Specification[b]	55	40	35	20
	Plateau	70–80	50–60	40–50	25–35
Modified Taliani	Specification[c]	60–80	40–60	40–60	20–40
	Plateau[d]	70–90	60–80	30–40	10–30

[a] 25 plus minutes to complete color change.
[b] 2.5 cc. of nitric oxide per gram for 13.4% nitrogen level. 2.0 cc. of nitric oxide per gram for 12.6% nitrogen level.
[c] Air atmosphere.
[d] Nitrogen atmosphere.

of the confining gas. In air, Figs. 9 and 10 show that hard water processing accelerates nitrate stabilization at both nitrogen levels and leads to a higher plateau. In nitrogen, on the other hand, while hard-water processing facilitates the attainment of the stability plateau, distilled-water processing appears to provide a somewhat higher ultimate stability. This is especially noticeable at the 12.6% nitrogen level.

Stability determinations on the 20 nitrate samples were also obtained by the Bergmann-Junk and the 134.5°C. heat test using standard procedures (*2*, *3*). Table VI shows a comparison of the results obtained by the three stability procedures. The comparison is based on the measured acid-boil requirements needed to achieve a definite end point, when this has been formally described, or to achieve a stability plateau beyond which further processing did not result in a significant increase in nitrate stability. Because of the nature of the curves in the transition region approaching the plateau, the latter values are expressed as a range of acid-boil times rather than as a single value.

Using the stability plateau as the most definitive measure of processing requirements, the following general conclusions can be formulated from the data of Table VI.

1. By all three methods for evaluating nitrate stability, the use of hard water greatly reduces processing requirements over those for distilled water. At the 13.4% nitrogen level, the stability plateau is attained in an average acid-boil time of about 50 hr. where all subsequent processing is conducted in hard water. An average of 75 hr. of acid-boil is necessary where all subsequent processing takes place in distilled water. The corresponding acid-boil requirements at

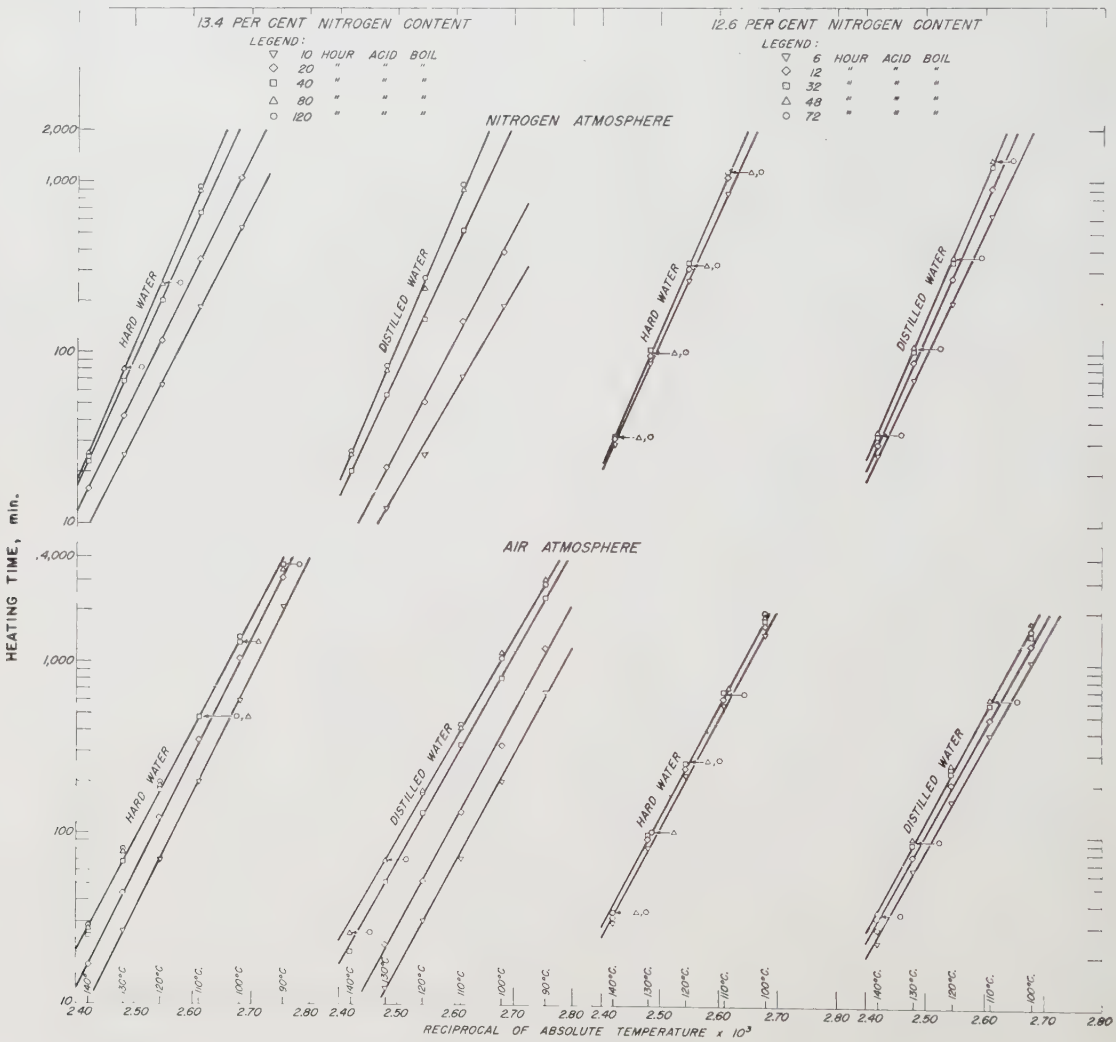


Fig. 11. Arrhenius-type plots of Taliani data for the 220-mm. pressure end point

the 12.6% nitrogen level are 25 and 45 hr., respectively.

As discussed in previous papers (*8, 10*), the stabilizing effectiveness of hard water may be associated with cationic absorption or with simple deposition of mineral constituents on fiber surfaces. Alkaline salts such as calcium carbonate could enhance nitrate stability by neutralization of retained acid or of thermally released acidic gases, thus masking the inherent stability of the cellulose nitrate.

2. The 134.5°C. heat tests appears to be most sensitive to the influence of processing water, exhibiting up to a fourfold difference between distilled water and hard water with respect to acid-boil requirements. As has been shown in previous work (*8*), this test is also sensitive to hard water from different sources. The Taliani procedure is the least sensitive of the three stability methods, and is itself less sensitive when conducted with nitrogen rather than air as the confining gas.

3. As might be expected from (1) and (2) above, agreement between tests is highest for those samples processed in distilled water. With conventional hard water processing, the modified Taliani procedure provides data in good agreement with that obtained by the Bergmann-Junk test, especially when the Taliani is conducted in air.

Kinetics of Thermal Degradation

The classical equation of Arrhenius, $k = se^{-E/RT}$, represents an empirical relation between reaction rate and temperature which has been found to hold for many chemical reactions. From the slope of the straight line produced by plotting log k as a function of $1/T$, the activation energy E of the reaction may be calculated, which in turn, provides the means for obtaining reaction rates at temperatures beyond the range of practical experimentation.

The curves in Fig. 8, in which gas pressure is plotted as a function of time of heating, clearly show that the thermal degradation of cellulose nitrate is a complex reaction. As such, true reaction-rate constants would be difficult to derive. For practical purposes, however, it is possible to make direct use of the time data in Tables II to V, plotting them as a function of reciprocal absolute temperature on semilogarithmic paper.

Figure 11 shows the families of straight lines produced by such a plot of the data for the 200-mm. pressure end point. The data for the other three test end points provide essentially identical graphs. Multiplying the slopes of these lines by 2.303 R provides the apparent activation energy values listed in Tables VII and VIII for the two nitrogen levels under study.

The most interesting aspect of the information presented in Fig. 11 and in Tables VII and VIII is the orderly behavior of the degradation process in spite of the wide variability in reaction conditions and in the stability level of the sample material. This finding is extremely important to the practical measurement and interpretation of nitrate stability. It provides confidence in the use of the Taliani procedure at elevated temperatures to predict the stability and service life of cellulose nitrate and cellulose nitrate propellants under normal storage conditions.

Closer observation of the data reveals that test and process variables do have small but significant effects on the nature of the degradation process. These may be summarized as follows.

Influence of Confining Gas. In air, the slopes of the

Table VII. Apparent Activation Energy as a Function of Taliani Variables—13.4% Nitrogen Level

Processing water	*Acid-boil time, hr.*	*200-mm. pressure end point, kcal.*[b] Air	Nitrogen	*1.00-cc. volume*[a] *end point, kcal.* Air	Nitrogen	*100-mm. pressure end point, kcal.* Air	Nitrogen	*0.50-cc. volume*[a] *end point, kcal.* Air	Nitrogen
Hard	10	31.6	30.7	30.9	30.7	32.7	31.3	32.9	30.9
	20	31.0	32.0	30.7	32.5	32.5	33.4	33.2	33.4
	40	29.7	35.5	29.5	35.5	32.0	36.0	32.9	36.3
	80	29.7	37.2	29.5	40.1	32.0	37.8	32.9	36.3
	120	29.7	37.2	29.5	40.1	32.0	37.8	32.9	36.3
Average		30.3	34.5	30.0	35.8	32.2	35.5	33.0	34.6
Distilled	10	29.0	26.9	28.2	26.9	31.8	29.1	31.6	28.6
	20	28.8	29.9	28.4	38.6	30.7	29.5	31.1	29.3
	40	27.8	33.9	28.2	33.6	30.5	34.7	31.8	34.4
	80	27.1	36.9	27.9	37.5	30.3	37.8	31.8	37.8
	120	27.1	36.9	27.9	37.5	30.3	37.8	31.8	37.8
Average		28.0	32.9	28.1	32.8	30.7	33.8	31.6	33.6

[a] Standard temperature and pressure.
[b] 1000 cal. per mole.

Table VIII. Apparent Activation Energy as a Function of Taliani Variables—12.6% Nitrogen Level

Processing water	*Acid-boil time, hr.*	*200-mm. pressure end point, kcal.*[b] Air	Nitrogen	*1.00-cc. volume*[a] *end point, kcal.* Air	Nitrogen	*100-mm. pressure end point, kcal.* Air	Nitrogen	*0.50-cc. volume*[a] *end point, kcal.* Air	Nitrogen
Hard	6	29.1	34.9	29.7	34.9	32.5	35.8	33.9	36.6
	16	29.5	36.6	29.7	36.9	32.7	37.5	33.9	36.6
	32	29.5	36.6	29.7	36.9	32.7	37.5	33.9	36.6
	48	29.5	36.6	29.7	36.9	32.7	37.5	33.9	36.6
	72	29.5	36.6	29.7	36.9	32.7	37.5	33.9	36.6
Average		29.4	36.3	29.7	36.5	32.6	37.2	33.9	36.6
Distilled	6	27.9	33.6	29.0	32.9	30.5	34.7	31.1	34.7
	16	28.4	35.8	29.3	35.8	32.0	36.6	32.2	36.3
	32	29.1	37.5	30.7	37.8	31.3	38.8	33.9	38.8
	48	29.1	37.5	30.7	37.8	31.3	38.8	33.9	38.8
	72	29.1	37.5	30.7	37.8	31.3	38.8	33.9	38.8
Average		28.7	36.4	30.1	36.4	31.3	37.5	33.0	37.5

[a] Standard temperature and pressure.
[b] 1000 cal. per mole.

Table IX. Calculated Heating Times to Attain a Taliani End Point of 200 mm. Hg Gas Pressure at 30°C. for Various Nitrate Samples

Nitrogen content, %	Acid-boil time, hr.	Time at 30°C. to attain 200 mm. Hg gas pressure, yr. — Air atmosphere — Distilled water	Air atmosphere — Hard water	Nitrogen atmosphere — Distilled water	Nitrogen atmosphere — Hard water
13.4	10	3.6	22.3	1.5	14.5
	120	9.3	30.3	627	674
12.6	6	11.6	25.5	139	292
	72	28.9	37.3	1077	675

lines and consequently the calculated activation energies are essentially constant and independent of the general level of nitrate stability (acid-boil time) for a given nitrogen content, processing water, and test end point. This implies that the reaction mechanism in air is not influenced by residual impurities present in the nitrate samples.

In nitrogen, on the other hand, the slopes of the lines and the corresponding activation energies for a common group of samples are seen to increase with increasing nitrate stability. Here, the removal of unstable residues by further acid boil appears to modify the course of the thermal degradation process, probably by reducing catalyst concentration. It may be considered that with air as the confining gas, oxygen takes an active role in the degradation mechanism, and its influence overshadows that due to residual impurities.

As a general rule, measurements conducted in a nitrogen atmosphere lead to higher activation energies than do measurements conducted in an air atmosphere. For nitrates at the stability plateau, the average difference in activation energy between the two test atmospheres is approximately 7 kcal. at the 13.4% nitrogen level and 6 kcal. at the 12.6% nitrogen level.

Influence of Processing Water. For the most part, hard-water processing yields nitrates that are more resistant to thermal degradation than nitrates similarly processed in distilled water solutions. This influence is greatest at the lower levels of nitrate stability where, as previously postulated, the buffering action of alkaline constituents may serve to reduce the catalytic activity of retained or evolved acidic materials. The water effect is considerably diminished at the stability plateau and may even be reversed when nitrogen rather than air is used as the confining gas.

Influence of Nitrogen Content. E is essentially independent of nitrogen content for cellulose nitrates fully stabilized by conventional hard-water processing. For nitrates similarly stabilized with distilled water solutions, E values are somewhat higher at the 12.6% nitrogen level than at the 13.4% nitrogen level.

Influence of Taliani End Point. With nitrogen as the confining gas, E appears to be independent of the particular stage of thermal degradation used as a basis for calculation. With air as the confining gas, E increases an average of approximately 4 kcal. on going from the 200-mm. pressure end point to the 0.50-cc. volume end point. Neglecting temperature effects, the latter is equivalent to an 80-mm. pressure end point.

DISCUSSION

The 27- to 40-kcal. range of apparent activation energies obtained by means of the Taliani procedure falls within the 27- to 67-kcal. range of values reported in the literature (*11* to *18*), nearly all of which were based on measurements in which the gaseous products of decomposition were continuously removed from the reaction zone either by evacuation or by entrainment in a stream of inert gas.

Will, (*18*) in his pioneering work on nitrate stability, reported an activation energy of 43.7 kcal. from the rate of liberation of nitrogen oxides in a continuous flow system. Wilfong (*17*), using a similar procedure, found a value of 46.7 kcal. Weight loss measurements in evacuated systems led to values of 27 to 46 kcal. (*11, 13, 14, 16*). Phillips (*13*), in a study of the rate of change of specific structural groups by means of infrared spectra, obtained an energy of 43.7 kcal. Based on an explosion test, Henkin and McGill (*12*) found two values for E—67 and 26.5 kcal. for low and high temperature explosions, respectively.

The intrinsic value of the findings of the present investigation lies in the fact that specific data are made available concerning the influence of commonly encountered variables on the rate and the nature of the thermal degradation process. In addition, the gaseous products of decomposition were maintained in contact with the residues as degradation proceeded, a situation which prevails under normal storage conditions

The remarkable uniformity of the Arrhenius plots of the Taliani data shows that the complex thermal degradation of cellulose nitrate can be described in a simple fashion. The straightness of the lines over the 50°C. temperature interval studied provides confidence in the extrapolation of test data to normal storage conditions. Table IX provides an illustration of the potential application of such kinetics data. Here, the time of heating required at 30°C., for the development of a gas pressure of 200 mm. of mercury, has been calculated from E and heating-time values determined at 130°C. It must be realized that these results hold only for the fixed conditions obtaining in the Taliani equipment.

The orderliness of the degradation process also simplifies the task of selecting a set of operating conditions for routine Taliani measurements of nitrite stability. Bath temperature can be as high as possible, consistent with safe operation and adequate timing accuracy. On this basis, a temperature of 130°C. would appear satisfactory. At 130°C., a fully stabilized nitrate at the 13.4% nitrogen level will require approximately 70 to 80 min. to attain a gas pressure of 200 mm. of mercury, or about 45 to 55 min. to reach a gas pressure of 100 mm. The corresponding times for a stable nitrate at the 12.6% nitrogen level are 90 to 100 min. and 65 to 75 min., respectively. These times permit adequate discrimination between samples of similar properties and also allow for measurements on relatively unstable material. If only comparatively stable nitrates were under study, it would be advantageous to raise the bath temperature to 140°C., where the test times described above would be reduced approximately threefold. With samples of low stability, however, decomposition might proceed so rapidly at 140°C. as to be hazardous. As for test atmosphere, there appears to be no advantage in specifying that routine measurements be conducted in an inert atmosphere rather than in air.

CONCLUSIONS

With respect to equipment, procedure, and precision of measurement, the modified Taliani method as developed in the present investigation appears to be well adapted for either research or routine control evaluation of nitrate stability. A minimum of operate attention and manipulation is required, and a permanent record of the course of thermal decomposition is obtained. Simultaneous study of multiple samples is practicable. The technique should prove of general applicability to any degradation reaction in which gaseous products are evolved or other changes in volume take place.

Application of the Arrhenius equation to Taliani data obtained at temperatures from 90° to 140°C. provides an information insight into the kinetics of the thermal degradation process. Nitrate degradation is seen to follow the course of a normal chemical reaction and to be only slightly influenced by the wide variety of nitrate processing and reaction conditions employed. This finding provides evidence that the results of accelerated high-temperature stability measurements can be used to provide a reliable interpretation of nitrate degradation under normal storage conditions.

LITERATURE CITED

1. Millett, M. A., "Stability Tests for Military Cellulose Nitrate and Cellulose Nitrate Propellants," A literature survey taken from *Chemical Abstracts* 1907–1957, June 18, 1957. *Tech. Abst. Bull.* (*ASTIA*) No. U57-4, p. 349, Item AD-135 801, October 15, 1957.
2. JAN-N-244 Amendment-1, December 27, 1945, joint ARMY–NAVY Specification—Nitrocellulose.
3. Buell, R. R., "The Bergmann-Junk Test for Nitrocellulose Stability, Part 1: Equipment and Methods in Use," Tech. Rept. No. 160, March 28, 1957, Liberty Powder Defense Corp., Badger Ordnance Works, Baraboo, Wis.
4. NAVORD-OD7904 Change 1, May 10, 1951, "Taliani Test for Determination of Stability of Solid Propellants," Navy Department, Bureau of Ordnance, Washington 25, D. C.
5. Taliani, M., *Gazz. Chim., ital.* 51 No. 1: 184 (1921).
6. Boyars, C. and Gough, W. G., *Anal. Chem.* 27: 957 (1955).
7. Wiggam, D. R. and Goodyear, E. S., *Ind. Eng. Chem.* (*Anal. Ed.*) 4: 78 (1932).
8. Millett, M. A., Saeman, J. F., and Masuelli, F. J., *Tappi* 41: 469 (1958).
9. Goujon, J., *Mem. de Artill. française* 8 No. 32: 537 (1929).
10. Millett, M. A., Schultz, J. S., and Saeman, J. F., *Tappi* 41: 560 (1958).
11. Andreev, K. K. and Samsonov, B. S., *Reports of Acad. of Sci. USSR* (*Phys. Chem.*) 114, No. 4: (1957).
12. Henkin, H. and McGill, R., *Ind. Eng. Chem.* 44: 1391 (1952).
13. Phillips, R. W., Orlick, C. A., and Steinberger, R. J., *Phys. Chem.* 59: 1034 (1955).
14. Schmid, G. and Beuttenmüller, E., Z., *Electrochem.* 50: 209 (1944).
(15) Smith, R. D., *Nature* 170: 844 (1952).
(16) Watanabe, S., *J Chem. Soc., Japan, Ind. Chem. Sect.* 58: 625 (1955).
(17) Wilfong, R. E., Penner, S. S., and Daniels, F., *J. Phys. and Colloid. Chem.* 54: 863 (1950).
18. Will, W., *Z. Angew. Chem.* 14: 774 (1901).

Received April 17, 1960. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

Measurement of Kamyr Continuous Kraft Digester Cooking Cycle Using Radioactive Tracers

RICHARD P. HAMILTON

Ten radioactive chips were traced through the two continuous kraft digesters at North Western Pulp and Power Ltd., Hinton, Alta. The isotope used as source of radiation was lanthanum 140. The path of the active chips was traced with ion chamber hand instruments and an automatic Geiger counting system. The purpose of the project was to measure the dwell-time and the time–temperature cycle of the Hinton digesters as a basis for further laboratory and mill studies. A time–temperature cycle was developed from the tracing data and the temperatures of the circulating liquors and the digester shell at various levels. The average of these results was used as a basis for a time–temperature cycle to be used for laboratory studies. Results obtained during operation at a low chip level in the digester pointed out the importance of maintaining a high chip level in order to obtain maximum and proper benefit of the dwell-time available. No spiraling or rotation of the active chip was noted during the descent through the digester. All chips came down in a straight vertical line. No evidence of channeling was obtained.

Two continuous Kamyr digesters have been operating at North Western Pulp and Power Ltd., Hinton, Alta., since the spring of 1957. These digesters cook a mixture of lodgepole pine and spruce to a 20 to 25 permanganate number level for bleaching to 89 G.E. brightness. Since the startup of the Hinton mill operational experience has indicated that these digesters produce a pulp which is fundamentally different from pulp from a batch digester. The variables which cause these differences were not thoroughly understood, indicating further study was required. To study kraft pulp variables under Kamyr continuous digester conditions, it was necessary to know the total cooking or dwell-time of a chip in the digester and the time-temperature cycle experienced by a chip as it passed through the continuous digester vessel. Measurements of chip travel through the vessel using ordinary techniques were impossible. Therefore, it was necessary to use radioactive tracing methods, sending a chip containing a radioactive isotope through the vessel, and following its movements with appropriate radiation-measuring devices.

The purpose of the project was to measure the dwell-time and time–temperature cycle of the Hinton Kamyr digesters as a basis for further laboratory studies of the variables connected with this type of continuous kraft cooking. Besides the measurement of dwell-time and rate of passage through various zones of the digester, it was hoped that this tracer study would provide useful information on the type of path a wood chip follows

Richard P. Hamilton, Group Leader Pulping Research, St. Regis Paper Co., Technical Division, Deferiet, N. Y.

through the vessel, i.e., does any channeling or spiraling occur.

DESCRIPTION OF KAMYR DIGESTER SYSTEM

It is important to be familiar with the basic operations of the Hinton Kamyr digesters and the various liquor flows in order to understand the requirements necessary to measure the time–temperature cycle. Figure 1 shows a simplified schematic flow diagram of a Hinton Kamyr digester. Many of the details have been left out here because they have been previously described by Smith and McCorry (*1*).

The Kamyr is a vertical downflow digester. The chips are continuously added at the top of the vessel and the pulp is continuously blown from the bottom. Referring to Fig. 1, chips from chip bin *A* are metered with a chip meter *B* into the low-pressure feeder *C*. The chips drop from the low-pressure feeder into the chip-steaming vessel *D*. The chips are screw-conveyed through the steaming vessel and are discharged into the chip chute *E*, which conveys the chips into the Kamyr high-pressure feeder *F*.

The high-pressure feeder is similar to a plug cock type valve with a number of ports. As the plug rotates, a given port becomes vertical. At this position chips are swept into the valve with liquor from the chip-chute pump *G*. As this port rotates to the horizontal position, the chips are swept from the valve and into the top of the digester with liquor from the top circulation pump *H*. White liquor for cooking is continuously added at the top of the digester.

From the entry point at the top, the chips descend vertically through the digester. The liquor is heated at the upper (1) and the lower heating zones (2). In both zones the liquor is extracted from the digester through screen plates, pumped through heat exchangers and returned to the digester through concentric downcomer pipes. The liquor flow from each circulating system is returned to the digester just above the upper extraction screen of its respective heating zone.

The chips continue to the bottom of the digester where the cooked chips are cooled to the desired temperature with cool black liquor, exit the vessel, pass through the extractor to the blow line and through variable opening orifice valve to the blow tank. The temperature in the cold blow zone and the hydrostatic pressure of the system are maintained by the proportional addition of cool black liquor and hot black liquor from the extractor to the lower part of the digester.

EXPERIMENTAL

A total of 10 traces were planned; six traces were to be made on no. 2 digester. This digester was to be fitted with a 96 Geiger tube counting and recording system, which would provide an accurate record of the chip velocity through the digester and the portion of the radioactive chip in the cross-sectional plane of the digester. Four traces were to be made on no. 1 digester. This vessel was not fitted with a Geiger counting and recording system. Tracing was to be done with hand instruments for this digester. It was also planned to trace the radioactive chips through no. 2 digester with hand instruments to augment the Geiger counting data.

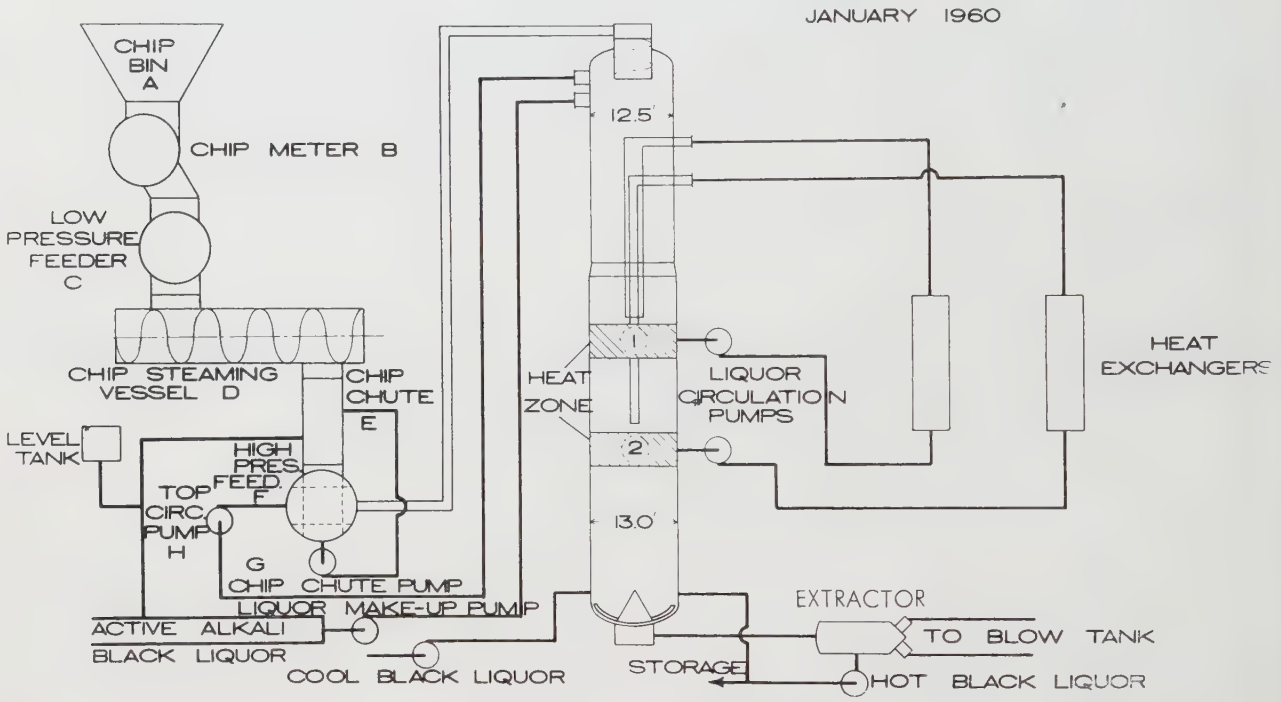


Fig. 1. Flow diagram of the Kamyr continuous digester—Hinton, Alta

During the tracing period the temperatures of circulating liquors and the digester surface at various points from the top of the vessel were to be recorded. The Kamyr cooking cycle was to be resolved by assembling the tracing data and the recorded temperatures of various zones of the digester into a time–temperature cooking curve.

Preparations

The Atomic Energy of Canada, Ltd. provided technical aid, built the Geiger counting system, prepared the isotopes, and handled the radioactive material during the experiments at the mill. Special equipment,

such as appropriate hand monitoring instruments and lead containers for transporting the isotopes, as required, was made available by this company.

Automatic Geiger Counter System. The automatic Geiger counter system was designed by Mr. R. Tolmie, of the Atomic Energy of Canada, Ltd., Commercial Products Division. This system consisted of a 1000-v. power source, a ratemeter counting system and a multipoint recorder. This system was connected to a 96 Geiger tube assembly on the outside wall of no. 2 digester at Hinton. This Geiger tube assembly consisted of 12 levels of 8 tubes per level around the perimeter of the digester. The first level was located 6 ft. from the top of the digester, and each succeeding level at 7-ft. intervals. The purpose of the Geiger tube system was to count and record the radiation from the radioactive chip as received at each individual Geiger tube at the various levels. The intensity of the radiation, as measured by the eight Geiger tubes in any one level, would locate the active chip in the cross-sectional plane of the digester as it passed each level The velocity of the chip could be measured by timing the chip between levels

Lanthanum 140 Isotope. Ten aluminum capsules, 2.4 cm. long and 0.78 cm. in diameter, and each containing 0.300 g. of lanthanum 139 oxide, were irradiated for 22 days in the NRX reactor at Chalk River, Ont. Lanthanum 139 is not radioactive. When placed in a high neutron flux, it absorbs one neutron and becomes lanthanum 140, a radioisotope with a half-life of 40.2. hr. It emits beta and gamma radiation.

Five of the aluminum capsules were located in an area of high neutron flux, 3.5×10^{13} neutron per sq. cm. per sec. in the NRX reactor, and five were placed in an area of lower neutron flux, 2.3×10^{13} neutron per sq. cm. per sec. This procedure was followed to prepare five 14 Curie sources and five 10 Curie sources. Because the amount of activity of the source was halved every 40 hr., it was necessary to prepare highly active sources at Chalk River. Two days were required in railroad transportation of the sources from Chalk River to Hinton, Alta. The time between the first and last trace at Hinton was expected to last several days; therefore, the five more radioactive sources were prepared to be used last in the tracing sequence. It was estimated that these sources would decay to an activity similar to that of the weaker sources used at the beginning of the trace.

Plastic Chip. Special requirements, created by the size of the digester, distance of the mill from the reactor and the half-life of the radioisotope, caused an unusual set of limiting circumstances. First, the diameter of the vessel and the thickness of the steel shell indicated that a strongly active radioisotope would be required if it were to be sensed and traced, should it descend through the middle of the digester. Fineman (*2*) reported tracing the path of radioactive chip containing copper wire through a Kamyr digester. He was limited to the amount of activity which could be given to the copper wire by the atomic reactor available in Sweden. The intensity of the radiation available from his radio isotope samples was not high enough and the radioactivity could not be sensed when a chip went down near the center of the digester.

A chip emitting sufficient radiation activity to be measured from the center of the Hinton digester would be considered hazardous if it were not recovered and disposed of in the proper manner. This made it impossible to place the radioisotope in its small aluminum container in a wooden chip because laboratory experiments established that radiation from the isotope would result in considerable degradation of the cellulose in the wood, causing a chip to disintegrate.

These problems were overcome by placing the radioisotope in a plastic chip. This material would have to be resistant, after exposure to considerable radiation, to normal conditions experienced during a kraft cook. Also, it was considered necessary that the plastic material not exceed a density of 1.3 g./cc.

Small samples of several plastic materials were tested under the alkaline cooking conditions of kraft liquor at high temperature and pressure. These samples were all subjected to gamma radiation to simulate the effect of storing an active source in the chip, and to include the effect of this activity on the alkali stability of the plastic. The radiation received by each sample was 2.24×10^7 roentgens. Plastic samples tested were: phenolic laminate, 1.27 g./cc.; Stycast resin (styrene polymer, Emerson Cumine, Inc., Canton, Mass.), 1.16 g./cc.; silicone rubber, 1.11 g./cc.; and Teflon, 2.14 g./cc.

Samples of each material were placed in a 1-lb. digester together with spruce chips. The contents were cooked by the kraft process. The cooking conditions were:

Active alkali, %	19
Sulfidity, %	13
Maximum temp., °F	330
Maximum pressure, p.s.i.g.	110
Time to max. temp., hr.	2
Time at max. temp., hr.	2

At the end of the cooking period the digester was relieved to atmospheric pressure and the contents dumped into a pail. The plastic specimens were washed with warm water, visually inspected and subjected to several blows with an ordinary carpenter's hammer. It was hoped that the impact of the hammer would simulate the forces the plastic chip would experience during blowing and pumping to the screening system. Results were:

1. *Phenolic laminate.* Withstood hammer blows, showed some tendency to delaminate, or crack, at the exposed ends. These cracks were not noticeable until the sample was airdried for several days. The cracks were about $^1/_8$ in. in depth, as measured from the exposed surface.
2. *Stycast resin.* Failed hammer-blow test immediately. Evidence of reaction with the alkali at surface of plastic was present.
3. *Silicone rubber.* Lost all rubber characteristics; softened.
4. *Teflon.* Showed only slight surface cracking, withstood hammer impact satisfactorily, but was eliminated from consideration because of high density.

Tygon plastic paint (U. S. Storeware Co., Akron, Ohio) was applied to several phenolic laminate samples. The painted plastic samples were placed in the digester with chips and subjected to a kraft cook, as described above. The surface cracking and delamination characteristics were substantially reduced by the Tygon paint.

Based upon the results of these experiments, it was

decided that the plastic chips would be made of phenolic laminate and painted with Tygon paint. The paint was green, which would also aid in locating the chip in the knotter screens.

The chips used during the trace were round , with a diameter of $1^{5}/_{16}$ in (see Fig. 2). The thickness was $^{1}/_{2}$ in. and the edges were beveled slightly. A $^{17}/_{64}$-in. hole was drilled $1^{3}/_{8}$ in. from one edge. This was followed by a $^{3}/_{8}$-in. drill to a depth of $^{15}/_{32}$ in. The first hole provided the space for the aluminum capsule containing the isotope. The large hole was theaded with a

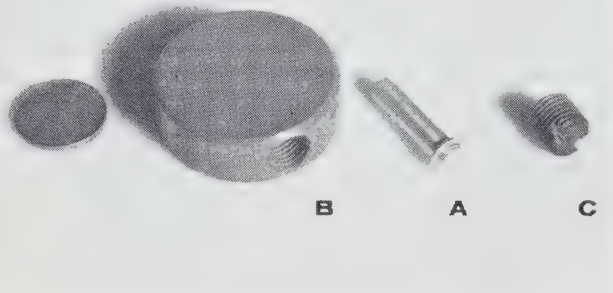


Fig. 2. Components of the plastic radioactive chip

The lanthanum 140 oxide was contained in the aluminum capsule *A*. This was inserted into the plastic chip *B*, and the hole plugged with the phenolic plastic screw *C*.

$^{3}/_{8}$ in. National Fine no. 24 tap. A threaded plug was prepared from phenolic laminate material to subsequently fill and seal the hole. The outside surface of the chip was painted with one coat of green Tygon plastic paint.

Thermocouple System. A thermocouple system was installed on each digester to provide more complete temperature data for various zones in the digester. Previously the temperature was measured on the various circulating liquors:

1. Upper circulation carrying chips into the digester
2. Upper heating or cooking zone
   a. Feed to digester
   b. Exit from digester
3. Lower heating or cooking zone
   a. Feed to digester
   b. Exit from digester
4. Bottom circulation

The thermocouple system consisted of 12 surface-type thermocouples attached to the outer wall of the digester shell. These thermocouples were located in areas where the temperature is not sensed with circulating liquors, i.e., between the upper circulation and upper heating zone, between the two heating zones and between the lower heating zone and the bottom of the digester. Only one thermocouple was attached at each sensing level. The 12 thermocouples for each digester were connected to a 24-point automatic recorder. Every 12 min. the instrument completed the cycle of recording a complete set of temperatures for both digesters.

Film Badges. Everyone working on the project and in the area of the digesters was provided with film badges to measure the amount of radioactivity each individual had absorbed. The two workers who actually handled the sources were also equipped with pocket dosimeters.

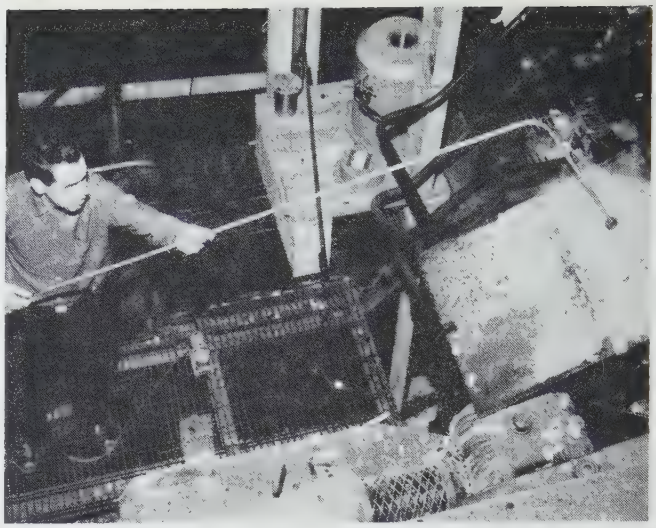


Fig. 3. Addition of a radioactive chip

The radioactive chip was withdrawn from the lead storage vessel, upper center, with the vacuum tool. The operator is ready to release the vacuum and drop the plastic chip into the chip feeder ahead of the chip steaming vessel.

Tracing Technique

Six radioactive chips were sent through digester no. 2., three were added to the chip feeder ahead of the steaming vessel on side *A*, and three were added on side *B*. The chips were added one at a time, traced through the digester and recovered before another chip was added to the digester system (see Figs. 3–6).

The lead-lined storage vessel containing the radio-

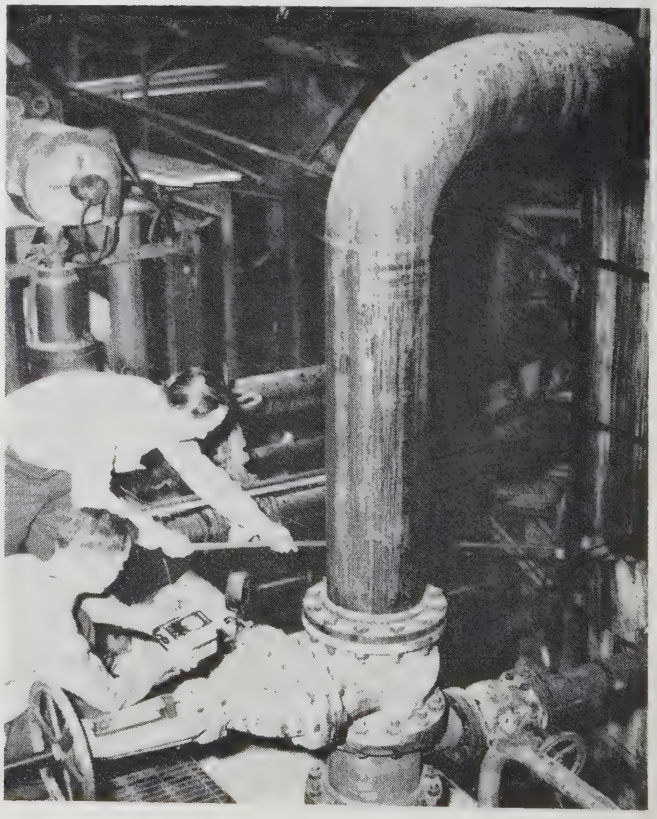


Fig. 4. Locating the chip near the top of the digester

An ion chamber field instrument is being used.

active source chips was located on a temporary platform adjacent to the chip meter. At the beginning of a trace the door of the chip meter was opened. A single plastic chip was lifted from the lead-lined vessel and dropped into the chip meter. The chip was lifted from the lead-lined vessel with a special tool. This tool consisted of a section of aluminum tubing bent in the shape of an L. The long section of the L was about 7 ft. long and was connected to a small vacuum pump with plastic tubing. The short section was about 2 ft. long, and was fitted with a small rubber suction cup at the end. The rubber cup was drilled out to allow the passage of air. A small vacuum-release hole was drilled in the aluminum tubing adjacent to the point where the plastic tubing was connected.

The normal sequence for a trace was to add the radioactive chip to the chip meter and start the stopwatch.

Fig. 5. Tracing the exit path of the chip around the bottom of the digester

An ion chamber hand instrument is being used.

The active chip was traced through the horizontal chip-steaming device with an ion chamber hand instrument, and the time it left the device noted on the watch. The time required to pass from the discharge of the steam vessel to the entrance of the digester was checked with another ion chamber counter located at the top of the digester. In general, this was an insignificant point as the time required was 10 to 15 sec.

Several operators with hand instruments began searching for the chip as soon as it entered the digester. Ion chamber hand instruments were used to locate the active chip and monitor the signal. The location by distance from the top of vessel and point on circumference was recorded at 6- to 8-ft. intervals as the radioactive source moved down through the digester.

Intensity of the radiation was measured and recorded at eight points on the circumference of the vessel. These data were useful in locating the chip in the cross-sectional plane of the digester. The radioactive chip was followed with the automatic Geiger counting system on no. 2 digester. This provided recorded data in addition to the tracing with hand instruments.

As the radioactive chip approached the bottom of the digester it was carefully monitored to be sure to observe any spiral or circular motion near the bottom. As soon as the chip left the extractor and entered the blow line the time was recorded and the digester trace was considered complete.

The chip was traced through the black stock system and into the knotters with a Geiger counter type alarm system. The chip was located in one of the five knotters with hand monitoring instruments. As soon as it was located in a knotter, the unit was isolated from production. The knot discharge was sealed so that the rejected knots and active chip would not drop into the knotter reject sluice. The black liquor showers on the knotter were shut off. The flow of stock into the unit was regulated to cause the active chip to move up the knotter screen and into the discharge chute. An instrument probe with a long lead was placed in the discharge chute. The personnel connected with recovery of the radioactive chip stood back and observed the approach of the active chip on the instrument. As the instrument rapidly advanced to a high reading the operator would move to the knotter unit, pick up the radioactive chip with a long-handled pincer type tool and place it in a lead storage vessel. The green paint helped to locate quickly the radioactive chip among the dark-brown kraft knots.

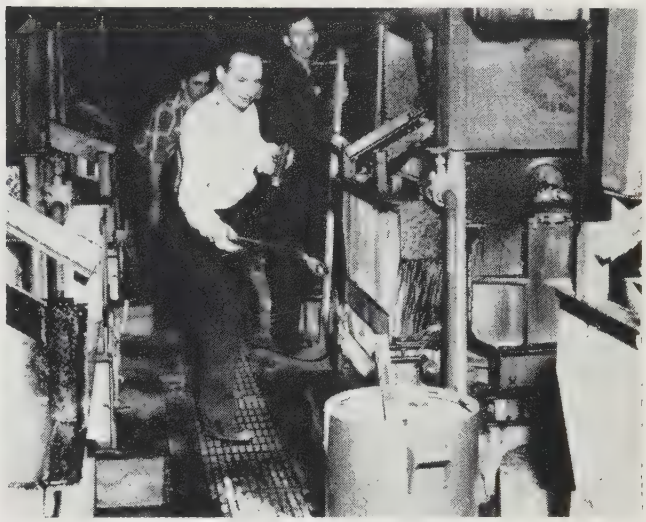


Fig. 6. Recovering the radioactive chip at the knotters

The operator is holding the chip with long-handled pincers. He has just removed this chip from the knotter screen on the right and is about to place it in the lead storage vessel in the lower center.

Digester operating data recorded during each trace included: thermocouple readings of the surface temperature at 12 points on the digester, liquor temperatures entering and leaving the upper and lower cooking zones, chip meter and white liquor integrator readings.

RESULTS

The tracing data recorded with the Geiger counting system and the ion chamber hand instruments provided sufficient data to determine and plot the rate of descent of the active chip versus tracing time. The depth of the chip inside the digester shell was calculated using radioactive field readings recorded during each trace. The translation of these readings into distance or depth of the active chip inside the digester was a difficult physical and mathematical problem. In calculating this distance it was necessary to take into consideration that the magnitude of a radiation field varies inversely with the square of the distance from the source to the sensing instrument. During the decay of lanthanum 140 three levels of gamma energy must be considered, together with the transmission of these three levels of energy through two adsorbing media: the kraft liquor and chips, and the steel shell of the digester. These depth results and method of calculation were completed and reported by Tolmie and Churchill (*3*).

The temperatures as recorded on the surface of the digester shell and the liquor circulation points were averaged and plotted versus the tracing time at which the radioactive chip passed each temperature sensing point. The tonnage rate for the digester as observed during each trace was calculated using data recorded during the trace. The weight of the wood charged was calculated by multiplying 30.7 (the measured average weight of ovendry wood passing through the chip meter per revolution) by the average revolutions per minute occurring during the trace. The yield in tons per day was determined by multiplying the weight of ovendry wood per minute by 46.7 average per cent yield, as measured during the week the traces were made, and converting to airdry tons of pulp per 24 hr. basis.

The results for Trace T-1, digester no. 2, are reported in Table I. Total dwell-time during this experiment was 2 hr. and 47 min. at a 262 airdry-ton-per-day production rate. The results for this trace are plotted in Fig. 7. A sketch of the digester is included on the left-hand side of Fig. 7 for reference. The descent of the active chip is plotted versus tracing time as indicated by the solid line. Rapid velocity occurs in the neck until the chip reaches the top of the chip charge in the digester. From this point the rate of descent decreases with travel down the digester, as indicated by the curve.

Table I. Digester Tracing and Temperature Data

Trace no.	Chip meter, av. r.p.m. (2 meters)	Chip steaming vessel dwell-time, sec.	Calculated tonnage rate, A.D. ton/day	Digester dwell-time: time, min.	Digester dwell-time: Distance from top of digester, ft.	Liquor temperatures, °F.: Top circulation	Cooking zone: Feed to digester	Cooking zone: Exit digester	Average thermocouple readings: Distance from top of digester, ft.	Average thermocouple readings: °F.	Blow temp., °F.	Permanganate number
T-1	22.7	120	262	0	0	222	315	302	0		283	23.0
				3	6		334	324	12	263		
Digester no. 2				12	13				18	275		
Entry side A				22	20				24	291		
				39	30				30	281		
				47	34				34	271		
				74	48				48	301		
				92	55				52	301		
				107	62				66	326		
				122	69				72	334		
				142	76				78	330		
				160	83				86	249		
				167 Total time	88 Blow				86	246		
T-10	23.7	123	273	0	0	220	308	283	0		278	25.4
				16	16		330	321	12	257		
				31	25.5				18	245		
Digester no. 1				39	30				24	274		
Entry side B				44	34				30	278		
				65	44.5				34	262		
				79	52				48	284		
				100	60.6				52	281		
				109	66				66	334		
				128	73				72	337		
				142	78				78	333		
				156	84				86	270		
				161 Total time	88 Blow				86	267		
T-2	24.1	130	278	0	0	225	297	281	0		275	24.9
				12	27		334	323	12	242		
				26	41				18	242		
Digester no. 2				38	48				24	244		
Entry side A				52	55				30	242		
				65	62				34	244		
				83	69				48	285		
				99	76				52	295		
				114	83				66	322		
				128 Total time	88 Blow				72	333		
									78	330		
									86	239		
									86	242		

Active alkali = 16.5% as Na_2O
Hydrostatic pressure: T-1:165, T-2:168, T-10:175 p.s.i.g.
Chip steaming vessel pressure: 13 p.s.i.g.; temperature 290°F.

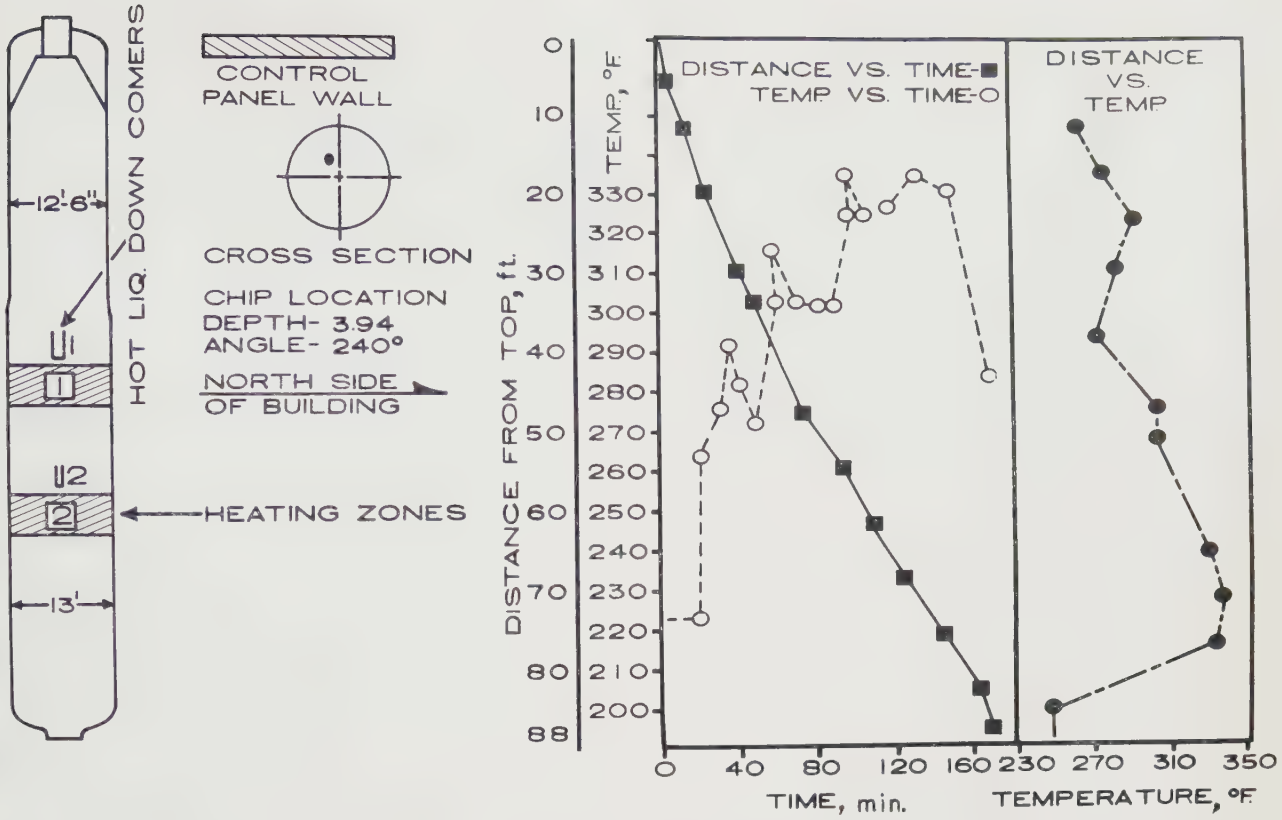


Fig. 7. Cooking cycle results, trace T-1

The rate of descent decreases with increasing density at the upper heating zone and below as the chip charge begins to pack more tightly on its travel downwards.

The temperature versus tracing or cooking time data is represented by the dotted line. The chips enter the digester at the temperature of the upper circulation liquor, which carried the chips into the digester from the high-pressure feeder. As soon as the chips leave the neck and upper cone the temperature rapidly increases. Proceeding down toward the first heating zone the temperature, as measured by the thermocouples, continues to increase until the 34-min. interval, or 27

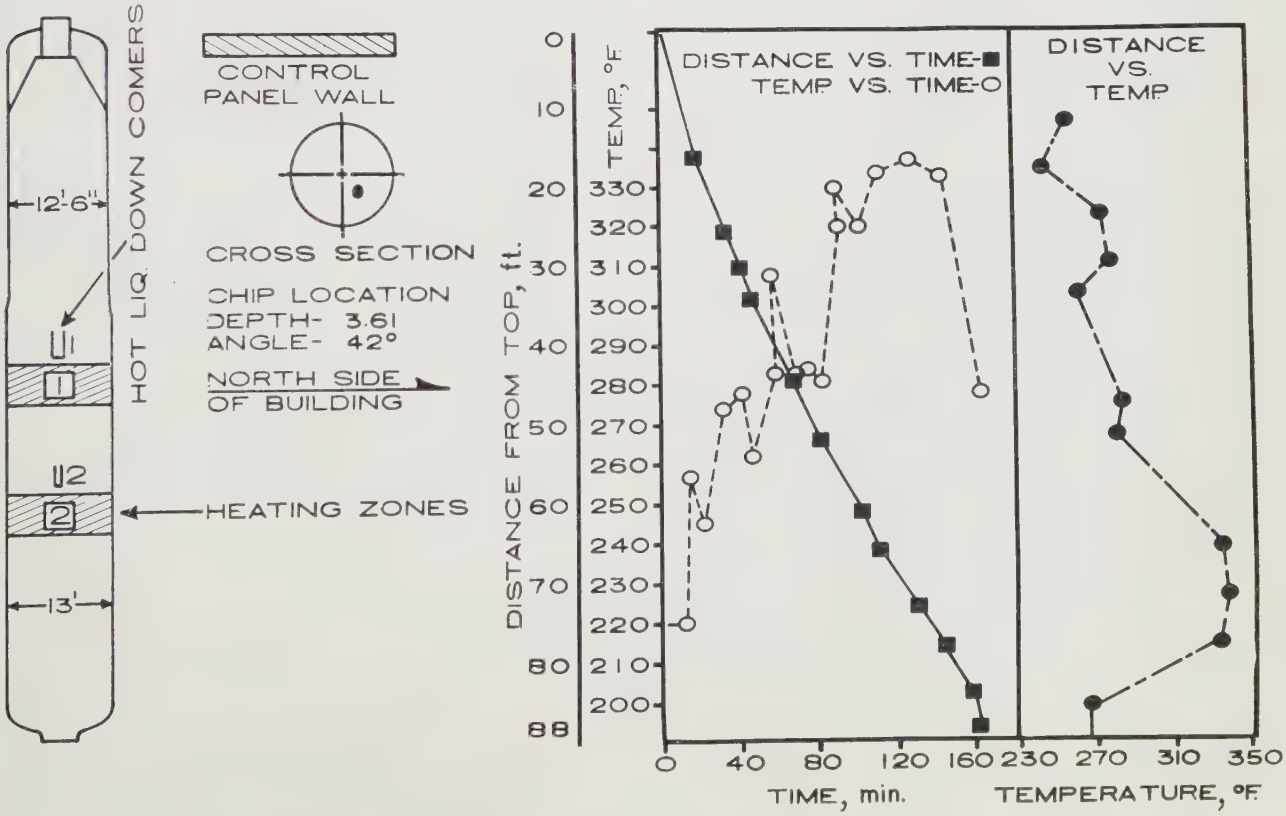


Fig. 8. Cooking cycle results, trace T-10

Table II. Chip Velocity

Distance from top of digester,	Velocity, ft./min. T-1	T-10	T-2
0	..	..	..
10	0.90	0.91	2.22
20	0.67	0.69	1.82
30	0.56	0.59	1.18
40	0.51	0.56	0.77
50	0.45	0.48	0.56
60	0.44	0.44	0.48
70	0.40	0.42	0.44
80	0.44	0.49	0.41
88	..	..	..

ft. from top point, was reached. Below this point two low temperatures were recorded with the thermocouples, indicating that an upward current of hot liquor may have been rising at the side on which the 27-ft. thermocouple is located.

As the active chip proceeds below the second heating zone a continuation in temperature increase is noted. Since no further heat is added this result indicates that an exothermic reaction is occurring during the cooking process.

Sloman (*4*) reported that an exothermic temperature rise was obtained near maximum cooking temperature when cooking eucalyptus by a two-stage soda process in a Kamyr continuous digester. He also reported that the presence of this reaction has been noted in batch digesters and in other continuous digester installations.

On the right side of each figure the distance from the top of the digester is plotted versus the digester shell temperature, as measured by the thermocouple system. The active chips travel down through the digester in a straight vertical line. No spiraling was noted during the descent in any of the 10 traces. The position of the vertical downward path of the active chip, for Trace T-1, is located in the cross-section drawing on Fig. 7. This chip descended in a path 3.96 ft. from the nearest digester wall. At the bottom it traveled straight to the exit pipe without rotation.

The data recorded for Trace T-10 for digester no. 1 are presented in Table I and plotted on Fig. 8. Total dwell-time during this experiment was 2 hr. and 41 min. at a 273-airdry-ton-per-day production rate. Generally speaking the data reported in Fig. 8 indicates similar curves from top of digester, and temperature versus tracing or cooking time as was recorded for Trace T-1.

This active chip made a complete rotation around the bottom of the digester before leaving through the exit pipe.

Tracing data for a period during low chip level operation in the digester were obtained during Trace T-2 and are reported in Table I and Fig. 9. Total dwell-time during this experiment was 2 hr. and 8 min. at a 278-airdry-ton-per-day production rate. The chip level during this experiment was not under proper control, i.e., it was not maintained at a high level near the top of the digester. The active chip descended rapidly through the first 27 ft. from the top of the digester, in 12 min. The 48-ft. level point, below the first heating zone, was reached in 38 min. Below this point the active chip decelerated to rates similar to those reported in this same cooking zone for traces at high initial chip level, i.e., as reported in Figs. 7 and 8. The thermocouple temperature variations did not occur during the early part of the trace while operating under this low chip level condition. The exit path for this chip at the bottom was straight to the center of the vessel with no rotation.

The chip velocity for the three traces reported was calculated at 10-ft. intervals down the digester, and is presented in Table II and Fig. 10. The velocity as plotted versus distance from top of digester, in Fig. 10, vividly demonstrates the effect of a low chip level on the

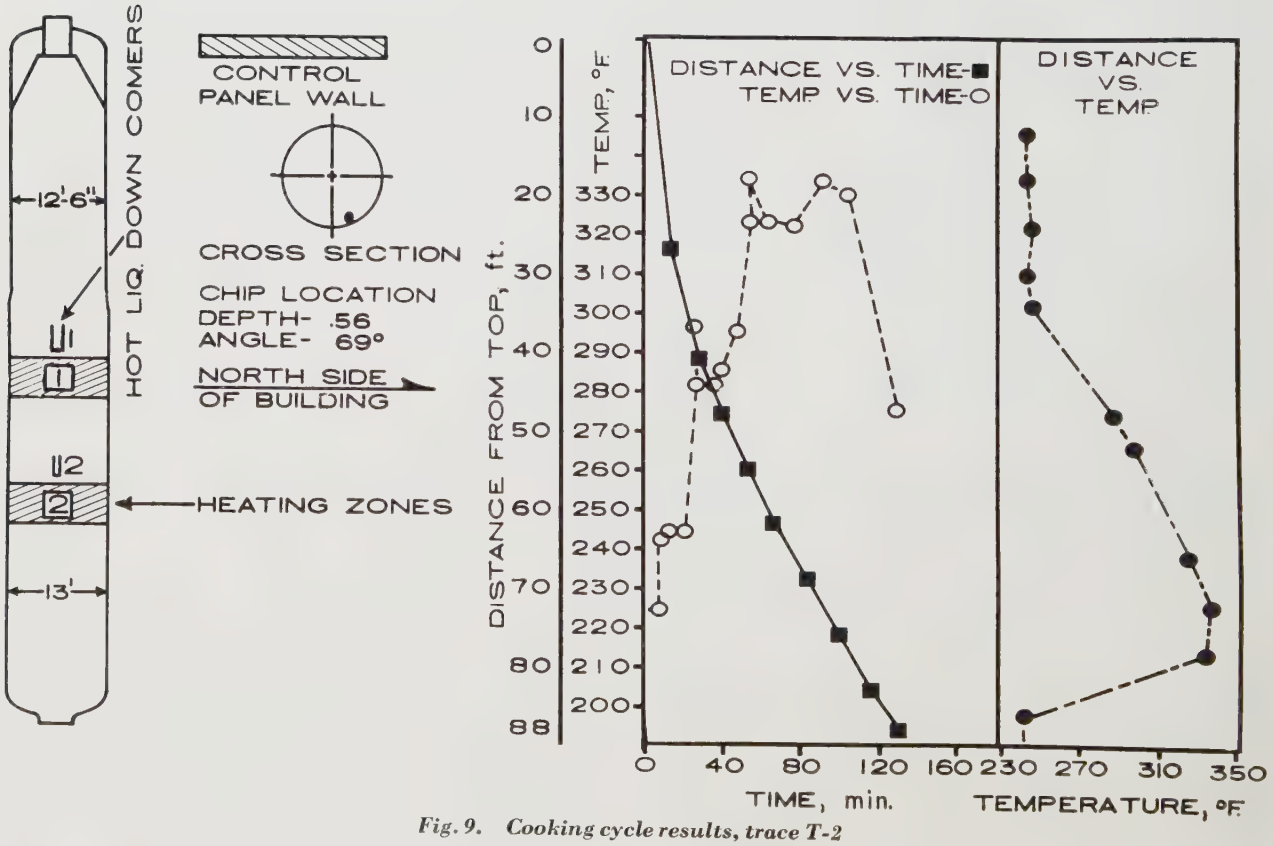


Fig. 9. Cooking cycle results, trace T-2

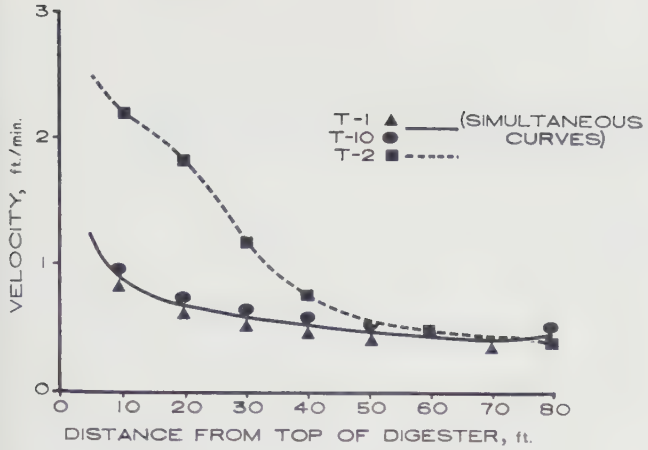


Fig. 10. Chip velocity

velocity in the upper 50 ft. of the digester. Below 50 ft. the velocity decelerates to rates similar to those obtained during traces at high chip level.

An average temperature versus dwell-time curve was prepared using the data obtained for both digesters. This curve is shown as the solid line in Fig. 11. The average dwell-time, as indicated by the curve, was 2 hr. and 35 min. at an average pulp production rate of 280 airdry tons per day. This average tracing curve was used as a basis for establishing the time–temperature schedule for laboratory-scale digestion experiments. This curve appears as the dotted line on Fig. 11. Peaks from hot liquor addition points and one valley from the unusual hot liquor flow pattern were eliminated from it. The average temperature at the two heating zones was estimated and a horizontal line was drawn to represent the temperature of the chips as they passed through the two heating zones. The time at maximum temperature

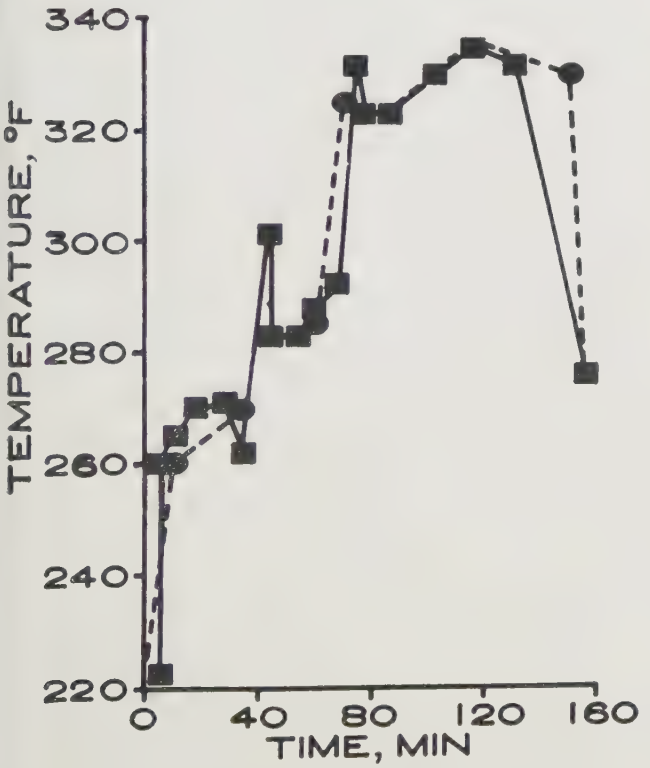


Fig. 11. Continuous cooking cycle for laboratory studies

■—Temperature vs. time for both digesters—
●—Temperature vs. time for laboratory studies

was held until the distance from the top of the digester was 83 ft. It was necessary to make this assumption because a temperature reading was not available for this point, and certainly, the temperature, as measured at no. 10 thermocouple, does not decrease directly in a straight line to the blow temperature. The two bottom thermocouple values were omitted from calculations of average temperature curves because these values were usually lower than the blow, or extractor liquor temperature, indicating that these thermocouples were measuring only localized cool liquor stream flows.

This temperature versus cooking time schedule will be used as a base line for laboratory study of digestion variables. Temperatures and time will be varied around this curve to obtain an indication of trends in pulp properties caused by changes in temperature levels.

CONCLUSIONS

The results of this project proved that lanthanum 140 is a suitable radioisotope for tracing the continuous flow of materials through a continuous digester. Several radioactive chips descended near the center of the digester and the radiation emitted was measurable with the Geiger tube counting system and portable ion chamber hand instruments. Tracing with hand instruments proved satisfactory for no. 1 digester, which was not equipped with the Geiger tube system. Probably, further tests could be made using only these portable instruments without the installation of the Geiger tube system.

The plastic chip proved to be a suitable carrier of the radioisotope and enabled easy recovery of the chip at the knotter screens. No spiraling or rotation of the radioactive chip was noted during the descent through the main part of the digester. All chips came down in a vertical line. Some rotation was noted at the bottom of no. 1 digester, just above the entry to blow line.

Evidence of channeling was not obtained. The data recorded during this tracer study indicated there was no definite pattern of velocities being higher near the center of the digester or lower near the shell. No correlation was found between chip depth and dwell-time.

This program was successful in obtaining data to prepare an average-temperature versus cooking-time curve representative of the average schedule of the Kamyr digesters at Hinton. This schedule, when smoothed for laboratory digester use, provided a basis for laboratory studies in a batch digester using Kamyr continuous digester time–temperature conditions.

By carefully limiting exposure to radiation during the addition and recovery of the radioactive chips no one connected with the project was exposed in excess of the permissible dose.

LITERATURE CITED

1. Smith, D. and McCorry, A. C., *Tappi* 40, No. 6: 247A–250A (1958).
2. Fineman, O., *Svensk Papperstidn.* 60, No. 11: 425–428 (1957).
3. Tolmie, R. W. and Churchill, T. R. Unpublished report, Atomic Energy of Canada, Ltd., Commercial Products Division, Ottawa, Ont., 60-4-RD-12, 3 RD-7.
4. Sloman, A. R., *Appita* Vol. 14, No. 2:57-64 (1960).

Received Jan. 10, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

The author wishes to express his appreciation to Mr. R. W. Tolmie and Mr. T. R. Churchill, Atomic Energy of Canada, Ltd., Commercial Products Division, for their technical assistance during the project.

Alkaline Hydrolysis of Representative Hardwoods

V. Additions and Corrections to Previous Studies

IRWIN A. PEARL, DONALD L. BEYER, and DONALD WHITNEY

Earlier studies on the alkaline hydrolysis of representative hardwoods, alkaline hydrolysis of the 75% propanol extractives of these hardwoods, and the acid hydrolysis of the 75% propanol extractives of these woods were continued on 10 new wood species: swamp cottonwood (*Populus heterophylla*), river birch (*Betula nigra*), chestnut oak (*Quercus montana*), black cherry (*Prunus serotina*), pin cherry (*Prunus pennsylvania*), mesquite (*Prosopis juliflora* var. *velutina*), ailanthus (*Ailanthus altissima*), eucalyptus (*Eucalyptus regnans*), white ash (*Fraxinus americana*), and lilac (*Syringa vulgaris*). The finding of acetovanillone and/or acetosyringone in alkaline and acid hydrolyzates of hardwoods necessitated the revision of quantitative data reported earlier for vanillin and/or syringaldehyde. All wood species investigated to date were examined qualitatively for acetovanillone and acetosyringone in their alkaline hydrolyzates, and quantitative data are reported for a number of species.

In previous papers of this series, studies on the alkaline hydrolysis of 46 representative hardwoods (*1, 2*), alkaline hydrolysis of the propanol extractives of these hardwoods (*3*), and the acid hydrolysis of the propanol extractives of these hardwoods (*4*) were reported. These studies have been continued, and the present paper reports data for 10 new species. In addition, the finding of acetovanillone and acetosyringone in the alkaline hydrolyzates of these woods necessitated the revision of quantitative data reported earlier for vanillin and syringaldehyde. These revised data are included in this paper.

The following new species of hardwoods were studied: swamp cottonwood (*Populus heterophylla*), river birch (*Betula nigra*), chestnut oak (*Quercus montana*), black cherry (*Prunus serotina*), pin cherry (*Prunus pennsylvania*), mesquite (*Prosopis juliflora* var. *velutina*), ailanthus (*Ailanthus altissima*), eucalyptus (*Eucalyptus regnans*), white ash (*Fraxinus americana*), and lilac (*Syringa vulgaris*). Alkaline hydrolyses of these woods and analyses by the previously reported procedures (*1, 2*) gave the results reported in Table I. Qualitative chromatographic data for alkaline hydrolysis products of the 75% propanol extractives of these woods in two solvent systems are given in Tables II and III, and quantitative data for the alkaline hydrolyses of these propanol extractives are reported in Table IV. Procedures used were those reported earlier for analogous studies on other hardwoods (*3*). Qualitative chromatographic data for the acid hydrolysis products of the propanol extractives of these woods in two solvent systems are given in Tables V and VI, and quantitative data for the phenolic hydrolysis products are shown in Table VII. Table VIII gives the sugars found in the hydrolysis products of the extractives after acid hydrolysis. Data for the last four tables were obtained by the procedures described in the earlier paper on acid hydrolysis (*4*).

During the course of the studies reported in the present paper, in connection with other studies in our laboratories (*5*), paper chromatographic procedures for the qualitative and quantitative determination of acetovanillone and acetosyringone in the presence of vanillin and syringaldehyde were evolved. Because the two solvent systems used for paper chromatography in the present studies did not satisfactorily separate

Irwin A. Pearl, Senior Research Associate and Chief; Donald L. Beyer, Research Aide; and Donald Whitney, Laboratory Assistant, Lignin Chemistry Group, The Institute of Paper Chemistry, Appleton, Wis.

Table I. Alkaline Hydrolysis of Hardwoods

Wood	Scientific name	Recovered wood, %[a]	Ether extract, %	Analysis of ether extract								
				Vanillin, %[b]	Syringaldehyde, %	Ratio S:V[c]	p-Hydroxybenzaldehyde, %	Vanillic acid, %	Syringic acid, %	Ferulic acid, %	p-Hydroxybenzoic acid, %	p-Coumaric acid, %
Swamp cottonwood	*Populus heterophylla*	64.1	3.16	2.2	1.4	0.6	0.0	1.8	1.9	0.0	41.7	0.0
River birch	*Betula nigra*	63.6	1.48	1.2	2.0	1.7	0.0	1.7	3.6	2.5	0.0	0.0
Chestnut oak	*Quercus montana*	65.5	1.98	1.4	1.7	1.2	0.0	2.5	5.2	3.5	0.0	0.0
Black cherry	*Prunus serotina*	54.5	2.88	0.8	1.4	1.7	5.5	1.5	2.7	2.2	2.3	3.6
Pin cherry	*Prunus pennsylvania*	60.4	1.40	1.3	1.5	1.2	2.3	4.6	6.1	2.6	2.8	2.2
Mesquite	*Prosopis juliflora*	50.2	2.64	0.6	1.2	2.0	0.7	1.5	2.9	2.5	0.0	0.0
Ailanthus	*Ailanthus altissima*	64.0	1.46	1.4	2.1	1.5	0.0	2.6	3.3	6.1	0.0	0.0
Eucalyptus	*Eucalyptus regnans*	73.4	0.90	2.1	5.4	2.6	0.0	2.0	2.4	0.0	0.0	0.0
White ash	*Fraxinus americana*	69.2	0.50	1.9	2.0	1.1	0.0	9.2	7.0	0.0	0.0	0.0
Lilac	*Syringa vulgaris*	67.5	3.24	0.6	0.9	1.5	0.0	1.2	2.2	1.9	0.0	0.0

[a] Yields of recovered wood and ether extract are on the basis of the original wood.
[b] Yields of vanillin and all other compounds are on the basis of the ether extract.
[c] The ratio of syringaldehyde to vanillin is on a weight basis.

Table II. Chromatographic Data for Acids and Phenols Fraction from Alkaline Hydrolysis of Propanol Extractives in Butanol–2% Aqueous Ammonia

	Butanol–2% aqueous ammonia R_f[a]											
	0.00	0.03	0.08[b]	0.10[c]	0.12[d]	0.16	0.27[e]	0.38[f]	0.44[g]	0.62	0.69	0.80	0.90
Populus heterophylla	X		X	X	C			X	X			X	
Betula nigra	X		X	X			X	X	X		X	X	
Quercus montana	X		X	X	B		X	X	X			X	
Prunus serotina	X	X	X	X	F	X	X	X	X[h]			X	
Prunus pennsylvania	X		X	X	D			X	X[h]	X		X	
Prosopis juliflora	X	X	X	X	A	X[i]		X	X[h]	X			
Ailanthus altissima	X		X	X	C		X	X	X			X	
Eucalyptus regnans	X		X	X			X	X	X			X	
Fraxinus americana	X		X	X	B		X	X	X			X	
Syringa vulgaris	X		X	X	B		X	X	X			X	X

[a] R_f determined by means of bis-diazotized benzidine spray.
[b] Syringic acid.
[c] Vanillicacid.
[d] This spot may be *p*-hydroxybenzoic acid, ferulic acid, *p*-coumaric acid, or any combination of these acids. Actual qualitative composition was determined by chromatography in benzene–formic acid developer (*1*). A = *p*-hydroxybenzoic acid; B = ferulic acid; C = *p*-hydroxybenzoic acid + ferulic acid; D = *p*-hydroxybenzoic acid + ferulic acid + *p*-coumaric acid; E = ferulic acid + *p*-coumaric acid; and F = *p*-coumaric acid + *p*-hydroxybenzoic acid.
[e] This spot is positive to 2,4-dinitrophenylhydrazine and Mäule reagents.
[f] Syringaldehyde.
[g] Vanillin.
[h] Also contains *p*-hydroxybenzaldehyde.
[i] This spot is positive to the 2,4-dinitrophenylhydrazine reagent.

vanillin and syringaldehyde from their corresponding methyl ketones, the ether extracts obtained after alkaline hydrolysis of all 56 representative hardwoods studied to date were resubmitted to qualitative paper chromatography for acetovanillone and acetosyringone by the procedure described in detail in the earlier paper (*5*). The results of this qualitative survey are given in Table IX.

The presence of acetosyringone and/or acetovanillone in these hydrolyzates affected the quantitative data for syringaldehyde and/or vanillin in previously reported studies in this series and in the quantitative studies of the present paper. It was impractical to re-evaluate all of the quantitative data reported in the past because of the quantitative status of the ether extracts after the substantial interval of time. However, several suitable extracts were available, and these were submitted to quantitative analysis for vanillin, syringaldehyde, acetovanillone, and acetosyringone by the previously described paper chromatographic and spectrophotometric procedures (*5*). The extracts included those from the 10 species of the present report and from the previously reported Fraser magnolia (*Magnolia fraseri*) and weeping willow (*Salix babylonica*). Comparative data for quantitative yields obtained by the old and the corrected procedures are given in Table X. Quantitative data for swamp cottonwood (*Populus heterophylla*), and pin cherry (*Prunus pennsylvania*) were obtained after the presence of acetovanillone and acetosyringone were known. Therefore, Table X does not include comparative data for these species, and values for vanillin and syringaldehyde given in the tables of this paper are all corrected values.

DISCUSSION OF RESULTS

Alkaline Hydrolysis of Hardwoods

From Table I it is seen that again the yields of ether extracts from the different woods is generally below 2%. However, in the present woods, three yielded ether extracts in greater amounts than did any of the 46 representative hardwoods reported earlier (*1*, *2*). These were swamp cottonwood (*Populus heterophylla*) with 3.16%, black cherry (*Prunus serotina*) with 2.88%, and lilac (*Syringa vulgaris*) with 3.24%. The yield of 3.24% from lilac wood after alkaline hydrolysis was the highest yield of ether extractives obtained from any of the 56 representative hardwoods studied to date. The 0.50% yield of ether extract from white ash (*Fraxinus americana*), was the lowest yield obtained to date, and the 50.2% value for recovered wood of mesquite (*Prosopis juliflora*, var. *velutina*) was the lowest recovered wood value obtained to date.

Again, vanillin and syringaldehyde were found in all woods, and, in all instances, their combined yield represented only a small percentage of the total ether extract. The ratio of syringaldehyde to vanillin on a weight basis was generally below 1.5, but two woods, chestnut oak (*Quercus montana*) and black cherry

Table III. Chromatographic Data for Acids and Phenols Fraction from Alkaline Hydrolysis of Propanol Extractives in 10:3:3 Butanol-Pyridine-Water

	10:3:3 Butanol-pyridine-water R_f[a]												
	0.00	0.02[g]	0.06	0.10	0.15	0.18	0.38[b]	0.44[c]	0.52[g]	0.56[d]	0.70	0.78[e]	0.84[f]
Populus heterophylla	X						X	B		C		X	X
Betula nigra	X		X				X	A				X	X
Quercus montana	X	X		X			X	B				X	X
Prunus serotina	X	X		X			X	A		E	X	X	X
Prunus pennsylvania	X			X			X	B		E		X	X
Prosopis juliflora	X		X	X		X[g]	X	B	X	D		X	X
Ailanthus altissima							X	B		C		X	X
Eucalyptus regnans							X	A				X	X
Fraxinus americana	X						X	B				X	X
Syringa vulgaris	X				X		X	B				X	X

[a] R_f determined by means of bis-diazotized benzidine spray.
[b] Syringic acid.
[c] This spot may be vanillic acid or ferulic acid or both. Ferulic acid is identified by its white fluorescence under ultraviolet light. Actual composition was determined by paper chromatography in benzene–formic acid developer (*1*). A = vanillic acid; B = vanillic acid + ferulic acid.
[d] This spot may be *p*-hydroxybenzoic acid or *p*-coumaric acid or both. Actual composition was determined by chromatography in benzene-formic acid developer. C = *p*-hydroxybenzoic acid; D = *p*-coumaric acid; E = *p*-hydroxybenzoic acid + *p*-coumaric acid.
[e] This spot is positive to 2,4-dinitrophenylhydrazine and Mäule reagents and contains syringaldehyde (and acetosyringone when present).
[f] This spot is positive to 2,4-dinitrophenylhydrazine and Mäule reagents and contains vanillin (and *p*-hydroxybenzaldehyde and acetovanillone when present).
[g] This spot is positive to the 2,4-dinitrophenylhydrazine reagent.

Table IV. Alkaline Hydrolysis of 75% Propanol Extracts of Hardwoods

Wood	Scientific name	Propanol extract, %[a]	Neutrals extract, %[b]	Acids and phenols extract, %[c]	Vanillin, %[c]	Syringaldehyde, %[c]	p-Hydroxybenzaldehyde, %[c]	Vanillic acid, %[c]	Syringic acid, %[c]	p-Hydroxybenzoic acid, %[c]	p-Coumaric acid, %[c]	Ferulic acid, %[c]	Insoluble tar, %[c]
Swamp cottonwood	*Populus heterophylla*	2.80	18.8	23.0	1.0	0.4	0.0	4.4	8.3	55.3	0.0	4.8	35.0
River birch	*Betula nigra*	2.19	3.5	9.5	1.1	1.3	0.0	8.3	12.5	0.0	0.0	0.0	56.0
Chestnut oak	*Quercus montana*	4.90	1.5	8.0	2.1	1.8	0.0	4.4	0.0	0.0	0.0	5.3	58.0
Black cherry	*Prunus serotina*	6.70	7.0	15.0	0.8	0.9	4.5	6.0	7.4	12.5	2.0	0.0	59.0
Pin cherry	*Prunus pennsylvania*	2.26	9.5	24.0	0.8	0.8	0.0	2.2	5.2	2.4	3.5	1.3	56.0
Mesquite	*Prosopis juliflora*	17.91	2.2	20.0	0.6	0.4	1.3	3.3	2.0	5.3	0.0	0.0	80.0
Ailanthus	*Ailanthus altissima*	3.59	3.5	9.5	1.7	1.3	0.0	4.8	5.2	1.6	0.0	2.4	64.0
Eucalyptus	*Eucalyptus regnans*	1.29	2.0	7.0	2.7	4.3	0.0	6.3	6.4	0.0	0.0	0.0	62.0
White ash	*Fraxinus americana*	5.83	2.5	7.5	2.0	2.0	0.0	9.5	8.7	0.0	0.0	5.5	34.5
Lilac	*Syringa vulgaris*	3.90	24.5	28.5	1.1	0.4	0.0	2.8	1.9	0.0	0.0	1.2	36.0

[a] Solids on basis of ovendry wood.
[b] Solids on basis of 75% propanol extractives.
[c] Basis of solids in acids and phenols extract.

(*Prunus serotina*), gave ratios of 1.7 and swamp cottonwood (*Populus heterophylla*) and ailanthus (*Ailanthus altissima*) gave ratios of greater than 2.

p-Hydroxybenzaldehyde was found in the alkaline hydrolyzate of three woods of the present study. These were the two cherries, *Prunus serotina* and *P. pennsylvania*, and mesquite. In the case of the two cherries, the yield of *p*-hydroxybenzaldehyde was much higher than the yield of either of the other aldehydes, and in the case of *P. serotina*, the yield was more than twice that of the vanillin and syringaldehyde combined. It should be noted that the two cherries also gave high yields of *p*-coumaric acid on alkaline hydrolysis. Since it was demonstrated earlier (*2*) that *p*-hydroxybenzaldehyde is not formed from alkaline hydrolysis or oxidation of *p*-coumaric acid, it appears that the cherry woods contain moieties which hydrolyze in the presence of boiling alkaline solution to give high yields of both *p*-hydroxybenzaldehyde and *p*-coumaric acid. *Prosopis juliflora* is the only wood studied so far that gave *p*-hydroxybenzaldehyde on alkaline hydrolysis and did not yield *p*-coumaric acid under the same conditions.

Continuing the earlier lists of woods (*1*, *2*), all new woods yielded vanillic and syringic acids upon alkaline hydrolysis, and, in all instances but one, the yield of syringic acid was greater than that of vanillic acid. Only in the case of white ash in which both acid yields were the highest obtained so far, was the vanillic acid-to-syringic acid ratio greater than one.

p-Hydroxybenzoic acid was found in the hydrolyzates of swamp cottonwood and the two cherry woods, black cherry and pin cherry. In accordance with earlier noted rules (*1*, *2*) the *Populus* species gave a very high percentage of *p*-hydroxybenzoic acid, but the other two species gave the acid in much smaller amounts. As in the case of woods studied earlier (*1*), the very high yield of *p*-hydroxybenzoic acid was accompanied by no ferulic acid whatsoever. Ferulic acid was found in most of the hydrolyzates, but its presence followed no family lines.

Of the 56 representative hardwoods studied to date, black cherry (*Prunus serotina*) is unique in that it is the only one which yielded all of the identified products tested for in these studies.

Alkaline Hydrolysis of 75% Propanol Extractives

The yields of 75% *n*-propanol extractives (see Table IV) of these 10 woods all fell within the limits of those of earlier woods (*3*) except that for mesquite. This yield of 17.91% was the only one obtained to date greater than 10%. The 80% yield of insoluble tar obtained on the alkaline hydrolysis of the mesquite extractives was also the highest yield of tar obtained to date. Yields of acids and phenols extracts after alkaline hydrolysis were relatively similar to those of previous woods with five woods giving from 15 to 28% yields and five woods giving less than 10% yields. The neutral fractions from swamp cottonwood and lilac hydrolyses were high and all the others were relatively low.

Table V. Chromatographic Data for Phenolic Material from Acid Hydrolysis of Propanol Extractives in Butanol–2% Aqueous Ammonia

	Butanol–2% aqueous ammonia R_f[a]												
	0.00	0.06	0.08[b]	0.10[c]	0.12[d]	0.21	0.31	0.38[e]	0.44[f]	0.52	0.60	0.67	0.79	0.88
Populus heterophylla	X		X	X	X			X	X		X[g]			
Betula nigra	X		X	X				X	X			X	X	X
Quercus montana	X		X	X				X	X					X
Prunus serotina	X		X	X			X[h]	X	X	X[h]		X		X
Prunus pennsylvania	X		X	X	X		X[h]	X	X	X[h]	X[g]		X	X
Prosopis juliflora	X	X	X	X		X[g]		X	X	X[i]	X[g]			
Ailanthus altissima	X		X	X				X	X					X
Eucalyptus regnans	X		X	X				X	X					X
Fraxinus americana	X		X	X				X	X				X	X
Syringa vulgaris	X		X	X				X	X					

[a] R_f determined by means of bis-diazotized benzidine spray.
[b] Syringic acid.
[c] Vanillic acid.
[d] *p*-Hydroxybenzoic acid.
[e] Syringaldehyde.
[f] Vanillin.
[g] Positive to 2,4-dinitrophenylhydrazine reagent.
[h] Bright red spot when sprayed with bis-diazotized benzidine reagent.
[i] Positive to Mäule reagents.

Table VI. Chromatographic Data for Phenolic Material from Acid Hydrolysis of Propanol Extractives in 10:3:3 Butanol-Pyridine-Water

	10:3:3 Butanol-pyridine-water R_f[a]								
	0.00	0.10	0.18	0.38[b]	0.44[c]	0.56[d]	0.73	0.78[e]	0.84[f]
Populus heterophylla	X			X	X	X		X	X
Betula nigra	X			X	X			X	X
Quercus montana	X	X		X	X			X	X
Prunus serotina				X	X			X	X
Prunus pennsylvania				X	X			X	X
Prosopis juliflora	X	X	X	X	X		X	X	X
Ailanthus altissima				X	X				X
Eucalyptus regnans				X	X			X	X
Fraxinus americana				X	X			X	X
Syringa vulgaris				X	X			X	X

[a] R_f determined by means of bis-diazotized benzidine spray.
[b] Syringic acid.
[c] Vanillic acid.
[d] *p*-Hydroxybenzoic acid.
[e] This spot contains syringaldehyde (and acetosyringone when present).
[f] This spot contains vanillin (and acetovanillone when present).

Qualitative chromatography of the acids and phenols fractions gave some interesting data (Tables II and III). None of the new woods gave products with butanol-aqueous ammonia R_f 0.14 or R_f 0.76 noted in the past (*3*) for several woods. Lilac was the only wood of this series which gave a product with butanol-aqueous ammonia R_f 0.90 given by many woods in the past, and river birch was the only wood giving a product with R_f 0.69, also given by many woods in the previous work. Mesquite was the only wood tested to date whose extractives did not yield material with butanol-aqueous ammonia R_f 0.80 or higher as determined by the bis-diazotized benzidine spray reagent. Mesquite was also unique in that it is the only wood tested to date whose extractives yielded a product with butanol-aqueous ammonia R_f 0.16 giving a positive reaction with 2,4-dinitrophenylhydrazine reagent. The nature of this carbonyl compound is not known at this time.

The data of Table I indicate that mesquite wood yielded no *p*-hydroxybenzoic acid upon alkaline hydrolysis. On the other hand, the data of Tables II, III, and IV indicate that the propanol extractives of this same wood yield *p*-hydroxybenzoic acid under the same conditions. The reason for this is not understood and may be accounted for in part by the sensitivity of the paper chromatographic procedure employed for detection. The amount of material employed for testing in the extractives experiment was considerably more than that employed in the entire wood experiment. It is also possible that the high quantitative value indicated in Table IV was due in part to unknown interfering materials in the mesquite extractives which gave fictitious values due to ultraviolet absorption in the *p*-hydroxybenzoic acid range. This will be investigated and reported in future papers.

Continuing the results of the earlier paper on alkaline hydrolysis of the extractives of representative hardwoods, all propanol extracts yielded vanillin, syringaldehyde, vanillic acid, and syringic acid, and all extracts gave a strong purple color with phloroglucinol and hydrochloric acid. The significance of these findings was discussed in detail in the previous paper (*3*).

The qualitative differences of the products of alkaline

Table VII. Acid Hydrolysis of 75% Propanol Extracts of Hardwoods

Wood	Scientific name	75% Propanol extract, %[a]	Ether extract, %[b]	Vanillin, %[c]	Syringaldehyde, %[c]	Vanillic acid, %[c]	Syringic acid, %[c]	*p*-Hydroxybenzoic acid, %[c]	Insoluble tar, %[b]
Swamp cottonwood	*Populus heterophylla*	2.80	32.0	0.3	0.3	11.7	7.2	19.4	52.0
River birch	*Betula nigra*	2.19	18.5	0.5	0.8	3.6	4.5	0.0	61.0
Chestnut oak	*Quercus montana*	4.90	5.0	3.3	3.0	14.5	13.5	0.0	62.0
Black cherry	*Prunus serotina*	6.70	12.0	0.8	1.0	3.5	3.8	0.0	60.0
Pin cherry	*Prunus pennsylvania*	2.26	22.0	0.4	0.6	2.6	1.6	1.1	58.0
Mesquite	*Prosopis juliflora*	17.91	22.0	0.5	0.4	2.0	1.5	0.0	55.0
Ailanthus	*Ailanthus altissima*	3.59	6.0	1.5	1.5	6.5	8.2	0.0	58.0
Eucalyptus	*Eucalyptus regnans*	1.29	5.5	2.5	3.0	15.7	13.5	0.0	63.0
White ash	*Fraxinus americana*	5.83	7.5	1.2	1.3	11.5	9.3	0.0	51.5
Lilac	*Syringa vulgaris*	3.90	51.0	0.3	0.5	1.7	2.1	0.0	40.0

[a] Solids on basis of ovendry wood.
Solids in ether extract of acid hydrolyzate based on 75% propanol extractives.
[c] Basis of solids in ether extract.

Table VIII. Sugars in 75% Propanol Extracts of Hardwoods Before and After Acid Hydrolysis

		Galactose, %		Glucose, %		Mannose, %		Arabinose, %		Xylose, %		Rhamnose, %	
Wood	Scientific name	B[b]	A[c]	B	A	B	A	B	A	B	A	B	A
Swamp cottonwood	*Populus heterophylla*	1.0	2.9	5.9	7.7	0.5	0.9	0.0	0.0	0.0	0.0	0.0	0.0
River birch	*Betula nigra*	0.3	1.1	1.0	4.0	0.0	0.6	0.0	0.0	0.0	1.3	0.0	0.0
Chestnut oak	*Quercus montana*	0.0	0.0	1.1	2.0	0.0	0.0	0.8	1.3	0.0	0.7	0.0	0.0
Black cherry	*Prunus serotina*	0.0	0.0	0.7	9.9	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Pin cherry	*Prunus pennsylvania*	0.7	1.3	3.3	7.9	0.4	1.6	0.0	0.8	0.0	0.6	0.0	0.5
Mesquite	*Prosopis juliflora*	0.0	0.0	0.4	0.7	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
Ailanthus	*Ailanthus altissima*	0.5	1.0	0.5	1.6	0.0	0.6	0.0	2.1	0.0	1.3	0.0	1.0
Eucalyptus	*Eucalyptus regnans*	0.5	0.8	0.9	1.2	0.0	0.0	3.2	5.0	0.9	2.2	0.0	0.0
White ash	*Fraxinus americana*	0.0	0.7	8.5	17.5	0.3	0.4	0.0	0.0	0.0	0.7	0.0	1.3
Lilac	*Syringa vulgaris*	0.0	1.7	8.6	15.6	0.0	1.1	0.0	1.2	0.0	0.7	0.0	3.8

[a] On basis of solids in 75% propanol extracts.
[b] Before hydrolysis.
[c] After hydrolysis.

hydrolysis of these extractives make possible a number of taxonomic classifications, especially between individual species in the same genus. It is too early to draw any general conclusions for genera or families from the data in those cases where only one species in a family was tested. Such cases included *Ailanthus altissima* (Simaroubaceae), *Prosopis juliflora* (Leguminosae), and *Eucalyptus regnans* (Myrtaceae).

Table IX. Qualitative Evaluation of Alkaline Hydrolyzates of Hardwoods for Acetovanillone and Acetosyringone

Wood	*Scientific name*	*Acetovanillone*	*Acetosyringone*
Black willow	*Salix nigra*	+	+
Weeping willow	*Salix babylonica*	+	+
Diamond willow	*Salix eriocephala*	−	+
Quaking aspen	*Populus tremuloides*	−	+
Bigtooth aspen	*Populus grandidentata*	+	+
Balsam poplar	*Populus tacamahaca*	−	+
Cottonwood	*Populus deltoides*	+	+
No. black cottonwood	*Populus trichocarpa*	+	+
Swamp cottonwood	*Populus heterophylla*	+	+
European white poplar	*Populus alba*	−	+
Lombardy poplar	*Populus nigra*	+	+
European aspen	*Populus tremula*	−	+
Butternut	*Juglans cinerea*	−	+
Shagbark hickory	*Carya ovata*	−	+
Yellow birch	*Betula lutea*	+	+
Paper birch	*Betula papyrifera*	+	+
River birch	*Betula nigra*	−	+
Red alder	*Alnus rubra*	+	+
American hornbeam	*Carpinus caroliniana*	−	+
Beech	*Fagus grandifolia*	+	+
Chestnut	*Castanea dentata*	+	+
White oak	*Quercus alba*	+	+
Overcup oak	*Quercus lyrata*	+	+
Chestnut oak	*Quercus montana*	+	+
Eastern red oak	*Quercus borealis*	−	+
Black oak	*Quercus velutina*	+	+
Southern red oak	*Quercus falcata*	−	+
Scarlet oak	*Quercus coccinea*	+	+
Blackjack oak	*Quercus marilandica*	+	+
Turkey oak	*Quercus catesbaei*	−	+
Willow oak	*Quercus phellos*	+	+
Water oak	*Quercus nigra*	+	+
American elm	*Ulmus americana*	+	+
Southern magnolia	*Magnolia grandiflora*	+	+
Sweetbay	*Magnolia virginiana*	+	+
Fraser magnolia	*Magnolia fraseri*	+	+
Yellow poplar	*Liriodendron tulipifera*	+	+
Sweet gum	*Liquidambar styraciflua*	+	+
American sycamore	*Platanus occidentalis*	+	+
Black cherry	*Prunus serotina*	+	+
Pin cherry	*Prunus pennsylvania*	+	+
Mesquite	*Prosopis juliflora*	+	+
Ailanthus	*Ailanthus altissima*	−	+
Eucalyptus	*Eucalyptus regnans*	+	+
Sugar maple	*Acer saccharum*	+	+
Red maple	*Acer rubrum*	+	+
Silver maple	*Acer saccharinum*	+	+
Box elder	*Acer negundo*	+	+
Basswood	*Tilia americana*	+	+
White basswood	*Tilia heterophylla*	−	+
Black gum	*Nyssa sylvatica*	+	+
Tupelo gum	*Nyssa aquatica*	+	+
White ash	*Fraxinus americana*	−	+
Black ash	*Fraxinus nigra*	+	+
Lilac	*Syringa vulgaris*	+	+
Northern catalpa	*Catalpa speciosa*	−	+

Pin cherry wood yielded *p*-hydroxybenzaldehyde upon direct hydrolysis with alkali, but its propanol extract yielded none. Most of the woods gave ferulic acid upon direct hydrolysis, but many of these same woods gave propanol extracts which did not yield ferulic acid on alkaline hydrolysis. In the case of swamp cottonwood, the reverse was true. No ferulic acid was obtained from the wood itself by alkaline hydrolysis, but the propanol extract yielded a considerable amount. No explanation of this latter phenomenon is available, but there is a possibility that unknown materials in the hydrolyzate of the wood masked the fluorescence by which ferulic acid is identified on paper chromatograms.

The syringaldehyde-vanillin ratios obtained for the hydrolysis of these wood extractives, except for the case of swamp cottonwood, were all greater than 1.0. This does not agree with ratios obtained for the majority of the woods tested in the previous study (*3*), but most of the new woods were from genera not previously studied.

For the most part, the quantitative data of Table IV are not very unusual. The *p*-hydroxybenzaldehyde yield for black cherry is the highest yield obtained for any wood extract, and the *p*-hydroxybenzoic acid yield for the same wood is the highest yield obtained for any wood extract not in the Salicaceae family.

Acid Hydrolysis of 75% Propanol Extractives

The yields of ether extracts obtained after acid hydrolysis of the propanol extractives of these 10 woods (Table IV) fall within the range of those obtained in the earlier study (*4*). The exceptionally high yield of 51% for lilac was second only to bigtooth aspen in the entire group of 56 representative hardwoods studied to date. This yield is accounted for in part by neutral materials as indicated by the data of Table IV, but even discounting the neutrals present, the yield is much higher than that obtained from the two ashes also belonging to the Oleaceae family.

The qualitative data of Tables V and VI indicated that mesquite (*Prosopis juliflora*) was the first and only wood tested so far whose propanol extractives did not yield a product with butanol-aqueous ammonia R_f 0.88 after hydrolysis with acid. In addition, mesquite extractives were the only extractives studied to date which gave a product positive to 2,4-dinitrophenylhydrazine with butanol-aqueous ammonia R_f 0.21. This product was one of the major components of the acid hydrolyzate of mesquite extractives and is probably the same compound found in the alkaline hydrolyzate of mesquite extractives with butanol-aqueous ammonia R_f 0.16. The difference in R_f value noted for the two hydrolyses is due to the fact that, in the acid hydrolysis, the compound is a major component, and, in the alkaline hydrolysis, the compound was only a minor component. The apparent R_f values of individual components in admixture is discussed in detail in a previous paper (*6*).

As in the earlier paper on acid hydrolysis of representative hardwoods (*4*), every wood tested in this series yielded vanillin, syringaldehyde, vanillic acid, and syringic acid. The quantitative data of Table VII

indicate that yields of individual compounds were less after acid hydrolysis of the propanol extractives than after alkaline hydrolysis (Table IV). However, in the case of vanillic acid and syringic acid yields of several acid hydrolyses, especially those of swamp cottonwood, chestnut oak, eucalyptus, and white ash the yields were considerably more than in the corresponding alkaline hydrolyses. These data confirm the earlier conclusion that vanillic and syringic acids are probably linked glycosidically in the propanol extractives (*6*, *7*). The low yield of *p*-hydroxybenzoic acid in the acid hydrolyzate of swamp cottonwood compared with the high yield obtained in the alkaline hydrolyzate of the same wood confirms the earlier hypothesis that *p*-hydroxybenzoic acid is ester-linked for the most part in woods of the Salicaceae family as first noted by Smith (*8*) for *Populus tremula*.

None of the woods studied in the present series yielded *p*-hydroxybenzaldehyde, *p*-coumaric acid, or ferulic acid when their propanol extractives were hydrolyzed with acid.

The quantitative sugar data of Table VIII indicate that glucose was present before hydrolysis in the propanol extractives of every wood tested in the present study, and except for the case of eucalyptus, was the chief sugar component before hydrolysis. In the case of eucalyptus, arabinose was the chief sugar component both before and after hydrolysis.

Galactose was found in five of the woods both before and after hydrolysis. Of the present woods, only the two members of the Oleaceae family, lilac and white ash, gave galactose after hydrolysis, but did not contain galactose before hydrolysis. Three of the woods yielded mannose both before and after hydrolysis, and four other woods yielded mannose after hydrolysis, but did not contain it before. Only two woods contained arabinose before hydrolysis, but six contained it after hydrolysis, and xylose was found in the acid hydrolyzates of seven of the wood extracts, but only one extract contained xylose before hydrolysis. None of the wood extracts contained rhamnose before hydrolysis, and only four contained it after hydrolysis. In all instances, no family relationships could be determined.

Acetovanillone and Acetosyringone in Alkaline Hydrolyzates

The qualitative data of Table IX indicate that the alkaline hydrolyzates of every one of the 56 representative hardwoods investigated to date contained acetosyringone. On the other hand, 16 of these woods did not yield acetovanillone under the same conditions of hydrolysis. The failure of certain woods to yield acetovanillone upon alkaline hydrolysis appeared to have no genus or family relationships, and might have taxonomic implications relative to individual species within a genus.

The quantitative data of Table X indicate that in some instances the amount of acetovanillone comprises a substantial percentage of the combined acetovanillone-vanillin mixture which was originally analyzed for vanillin alone (*1*, *2*). Similarly, acetosyringone comprises a high percentage of the acetosyringone-syringaldehyde mixture originally analyzed for syringaldehyde alone. Therefore, it is probable that the yields of vanillin and syringaldehyde reported in the earlier papers on alkaline hydrolysis of both the representative hardwoods and their propanol extractives are somewhat high, and that considerable acetosyringone and acetovanillone were actually present. The data of Table X suggest that where comparative results are at hand, the combined yield of acetovanillone and corrected vanillin is just slightly higher than the originally reported vanillin yield. On the other hand, the combined yield of acetosyringone and corrected syringaldehyde are usually substantially higher than the originally reported syringaldehyde yield.

Again it should be pointed out that the results reported in this paper, as in the previous papers of this series, are preliminary in nature because, in almost all cases, they reflect experimental data from single specimens of individual species. Possible variations discussed earlier (*1*) apply to the results and discussions contained herein.

Table X. Comparative Data for Vanillin and Syringaldehyde in the Presence of Acetovanillone and Acetosyringone

Wood	*Scientific name*	*Vanillin, %*[a] *A*[b]	*B*[c]	*Syringaldehyde, %*[a] *A*[b]	*B*[d]	*Acetovanillone, %*[a]	*Acetosyringone, %*[a]
Weeping willow	*Salix babylonica*	1.9	1.6	2.0	1.3	0.4	0.8
Swamp cottonwood	*Populus heterophylla*		2.2		1.4	0.3	1.4
River birch	*Betula nigra*	1.2	1.2	2.0	1.1	0.0	1.2
Chestnut oak	*Quercus montana*	1.4	0.8	1.7	0.9	0.7	1.0
Fraser magnolia	*Magnolia fraseri*	1.0	0.4	2.2	1.3	0.7	1.2
Black cherry	*Prunus serotina*	0 8	0.4	1.4	0.8	0.5	0.6
Pin cherry	*Prunus pennsylvania*		1.3		1.5	0.6	0.9
Mesquite	*Prosopis juliflora*	0.6	0.4	1.2	1.0	0.3	0.3
Ailanthus	*Ailanthus altissima*	1.4	1.4	2.1	1.3	0.0	1.0
White ash	*Fraxinus americana*	1.9	1.9	5.0	2.8	0.0	2.8
Lilac	*Syringa vulgaris*	0.6	0.4	0.9	0.6	0.3	0.4

[a] Yields are on the basis of the ether extractives after acidification of the alkaline hydrolyzates.
[b] Originally reported value.
[c] Value corrected for acetovanillone present.
[d] Value corrected for acetosyringone present.

LITERATURE CITED

1. Pearl, I. A., Beyer, D. L., Johnson, B., and Wilkinson, S., *Tappi* 40: 374 (1957).
2. Pearl, I. A., Beyer, D. L., and Johnson, B., *Tappi* 41: 255 (1958).
3. Pearl, I. A., Beyer, D. L., Lee, S. S., and Laskowski, D., *Tappi* 42: 61 (1959).
4. Pearl, I. A., Beyer, D. L., and Laskowski, D., *Tappi* 42: 949 (1959).
5. Pearl, I. A. and Beyer, D. L., *Tappi* 42: 800 (1959).
6. Pearl, I. A., and Beyer, D. L., *J. Am. Chem. Soc.* 76: 6106 (1954).
7. Pearl, I. A., Beyer, D. L., and Laskowski, D., *J. Org. Chem.* 24: 443 (1959).
8. Smith, D. C. C., *J. Chem. Soc.* 1955: 2347.

RECEIVED April 12, 1961.

Hydroxyethylated Cotton Linters with Low Levels of Substitution

ROBERT H. GILLESPIE, MARJORIE MUELLER, HAROLD SWENSON, and KYLE WARD, JR.

When cotton linters are hydroxyethylated to low levels of substitution, their insoluble, fibrous form is retained, but their physical and chemical properties are changed. A better understanding was desired of how these changes were brought about and to what extent they occurred. In this study, cotton linters were hydroxyethylated by basic catalysis under widely different conditions. The products were characterized as to substitution level, solubility in solutions of alkali, and by x-ray diffraction. The reaction with ethylene oxide was not simply a surface reaction. Substitution took place readily within the fiber structure. Ethylene oxide was unable to penetrate the crystallite regions of the fiber until the alkali concentration was above 10% during the reaction. These results show how cellulosic fibers may be modified by hydroxyethylation to provide improved properties that should prove useful in the papermaking and textile fields.

INTRODUCTION

MANY attempts have been made in the past to use cotton linters as papermaking fibers, without much success. The thick, stubby fibers fibrillate upon beating, but they do not develop a desirable level of tensile strength or of tear and fold resistance. In this regard, cotton linters differ considerably from the behavior of the long lint fibers of the cotton plant. The efforts that have been made to overcome these deficiencies have been many. One of the most successful means of improving the papermaking properties of cotton linters involves the chemical modification of the fibers. In fact, this method has become commercially attractive, and chemically modified products are now available on the open market.

A variety of groups have been introduced into the cellulose molecule at low levels of substitution in order to bring about this improvement without disturbing the valuable property of insolubility. Acetylation was studied by Bletzinger (*1*), Aiken (*2*), and Harrison (*3*), and methylation by Jayme and Froundjian (*4*). Carboxymethylation was studied by Walecka (*5*) and Talwar (*6*). Harpham (*7*) has described cyanoethylation, carboxymethylation, hydroxypropylation and hydroxyethylation, while Spadaro and co-workers (*8*) also described hydroxyethylated and cyanoethylated fibers. Meanwhile, work at The Institute of Paper Chemistry, which was reviewed by Ward (*9*), had shown that hydroxyethylated cotton linters were particularly attractive as papermaking fibers. However, little was known about the changes that took place within the fibers during hydroxyethylation, and whether or not different reaction conditions might produce fibers having decidedly different properties. This study was undertaken in an endeavor to shed some light upon the important factors that govern the properties of hydroxyethylated cotton linters.

In this investigation, cotton linters were chemically modified by ethylene oxide, using basic catalysis. Long and Pritchard (*10*) showed recently that the basic hydrolysis of oxirane rings proceeds by an SN_2 mechanism as shown in Fig. 1. Reaction 1 is slow and rate-determining and is the nucleophilic attack of a hydroxyl ion on a ring carbon to produce an anionic product. This product reacts very rapidly with water to form the glycol. The presence of water is, therefore, a requirement of the reaction. McKelvey, Webre, and Klein (*11*) suggest a similar reaction with cellulose, using the reasonable assumption that a cellulosate anion forms in the presence of alkali. This leads to a competitive reaction between hydroxyl ions and cellulosate ions and possibly even with the ionic product of reaction 1 for the epoxide. The concentration of both the hydroxyl and the cellulosate ions would be expected to increase with alkali concentration, leading to an increase in the overall rate of reaction. The locus of reaction would also be expected to depend upon the relative rates involved—the rate of reaction and the rate of diffusion of ethylene oxide into the fiber structure. The reaction can stop after the formation of a

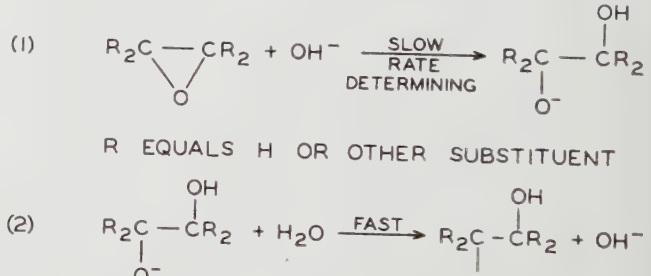


Fig. 1. Basic hydrolysis of oxirane rings

monoether or it can form linear graft polymers. The ratio of mono-to-poly substitution would also be expected to vary with reaction conditions.

Increasing alkali concentration can also bring about other interactions with cellulose that are more familiar. These interactions include swelling effects with the attendant increase in the number of hydroxyls available for reaction, and the change in crystal lattice pattern from cellulose I to cellulose II as mercerization concentrations are reached. With these interactions in mind a series of samples were prepared at various levels of substitution made under the conditions shown in Table I.

ROBERT H. GILLESPIE, Research Associate, MARJORIE MUELLER, Laboratory Assistant, HAROLD SWENSON, Research Associate, and KYLE WARD, JR., Chief, Cellulose Group, The Institute of Paper Chemistry, Appleton, Wis. Present address: Robert H. Gillespie, Forest Products Laboratory, Madison, Wis. Marjorie Mueller, present address: Lutheran Hospital School of Nursing, St. Louis 18, Mo. Work performed at The Institute of Paper Chemistry.

Table I. Conditions Used for the Hydroxyethylation of Cotton Linters

Alkali presteep concn., %	*Intermediate treatment*	*Alkali concn. E.O. reaction, %*
2	...	2
..	Beaten	2
5	...	5
10	...	10
10	...	2
15	...	15
20	...	20
20	...	2
20	Beaten	2

EXPERIMENTAL

The cotton linters were steeped in alkali as a pretreatment to vary the swelling and activating conditions. Excess solution was squeezed out to a ratio of about 1 part cellulose to 2 parts of solution, after which the alkali cellulose was shredded and reacted with ethylene oxide. In some cases the same alkali concentration was used for both the pretreatment and reaction steps. In others the pretreatment alkali was neutralized and washed out before applying a new concentration, usually only 2%, for the reaction stage. In other cases the fibers were beaten in a Valley beater at one stage or another in their preparation for reaction.

The hydroxyethylated fibers were evaluated for substitution level, for solubility behavior in various concentrations of alkali, and for their ability to diffract an x-ray beam. The Morgan method (*12*) was used to analyze for the moles of substitution per anhydroglucose unit. The solubility determinations were made by a modification of the Swedish method (*13*) that is used to measure the alkali solubility of pulps. This method depends upon the oxidation by dichromate for the organic matter dissolved in a sodium hydroxide solution. In this work, alkali solutions of different concentration were used. A weighed sample was held in contact with the alkali solution at one of two different temperatures, 25°C. and 3°C., for 24 hr. before analysis.

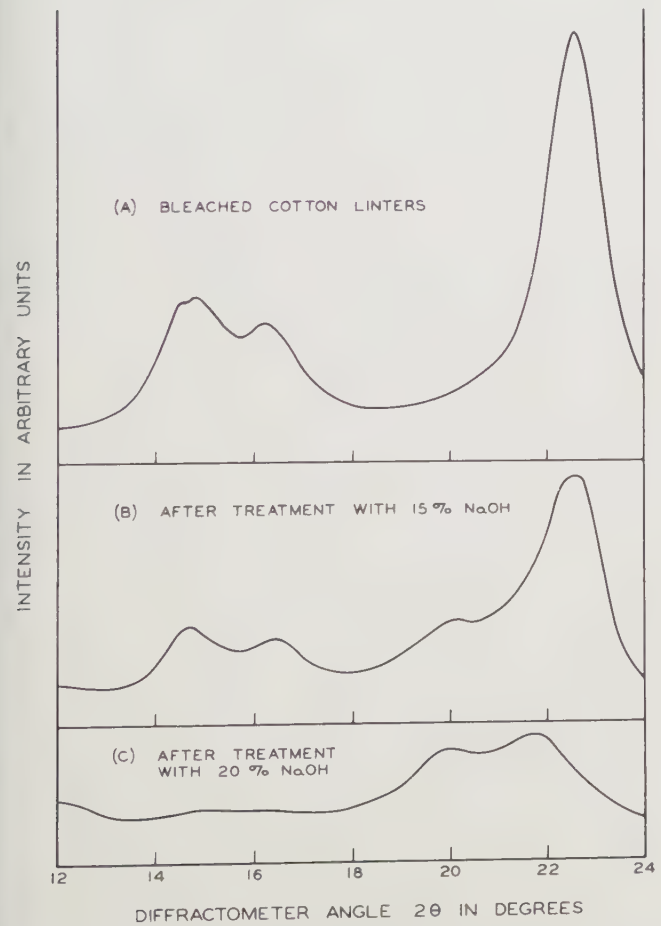
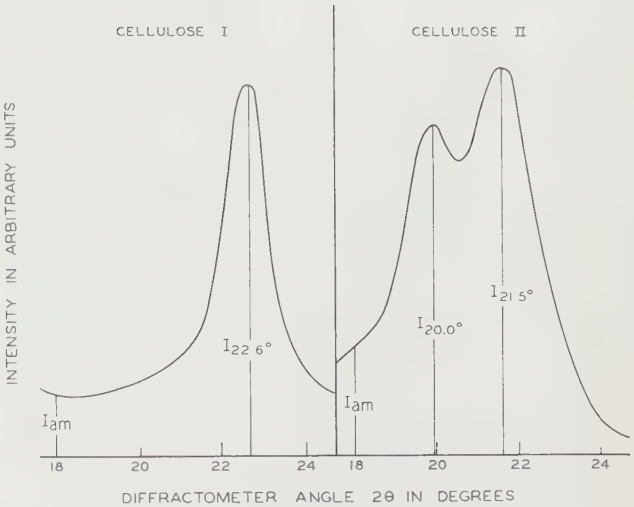


Fig. 2. Comparison of diffractometer tracings from (A) bleached cotton linters (B) after treatment of (A) with 15% NaOH, and (C) after treatment of (A) with 20% NaOH



Molecular order index (MOI) = $[I_{rp} - I_{am})/I_{rp}] \times 100$. Reference peaks at 20.0, 21.5, 22.6 deg. Amorphous peak at 18 deg. Use with cellulose I (*14*).

Fig. 3. Method of calculating molecular order indices

EVALUATION OF X-RAY DIAGRAMS

The x-ray diffraction measurements were made on disks pressed from fibers that had been ground to pass a 20-mesh screen. A Norelco x-ray unit operating with parafocusing geometry was used. The method of analyzing the diffractograms required some careful consideration. A large number of samples were to be evaluated, and precise quantitative values were not required. An empirical method could be used if one were found that could be applied to both cellulose I and cellulose II, as well as mixtures of the two. Typical diffractograms of these three conditions are shown in Fig. 2. Tracing (*A*) for the bleached cotton linters shows the (002) plane diffraction peak at approximately $2\theta = 22.6°$, the ($10\bar{1}$) peak at 16.3°, and the (101) peak at about 14.8°. Partial mercerization took place when these linters were treated with 15% alkali at room temperature. This is evident in tracing (*B*), which shows a decrease in the height of the (002) plane diffraction peak with the base of the peak becoming broader and less well defined as the ($10\bar{1}$) diffraction peak of the cellulose II lattice becomes evident at about $2\theta = 20.0°$. The height of both the (101) and ($10\bar{1}$) peaks of the cellulose I pattern have also decreased. The effect of more complete mercerization, as brought about by treatment of the cotton linters with 20% alkali at room temperature is illustrated by tracing (*C*). Here the (002) peak is further reduced in height and has shifted to an angle 2θ of about 21.5°. The peak from the ($10\bar{1}$) plane has increased in height at

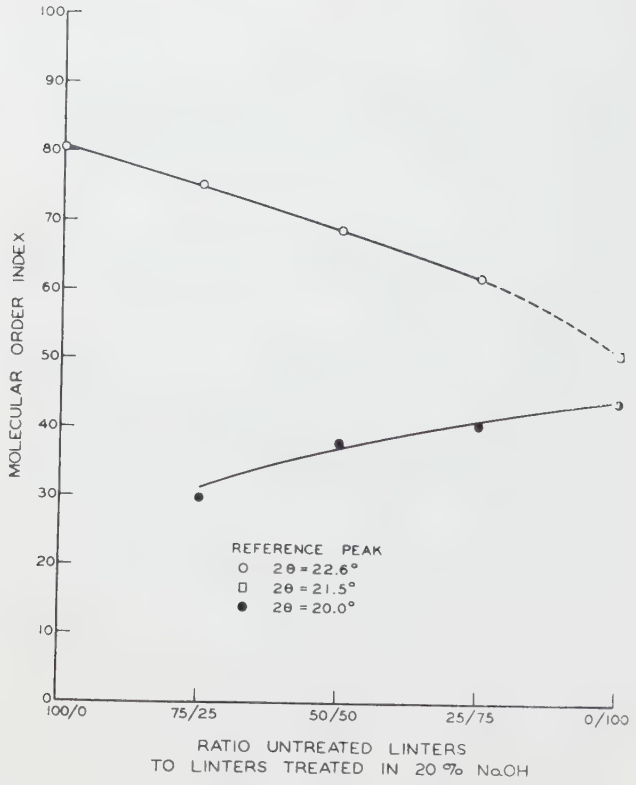


Fig. 4. The change in molecular order index with increasing proportions of mercerized fibers

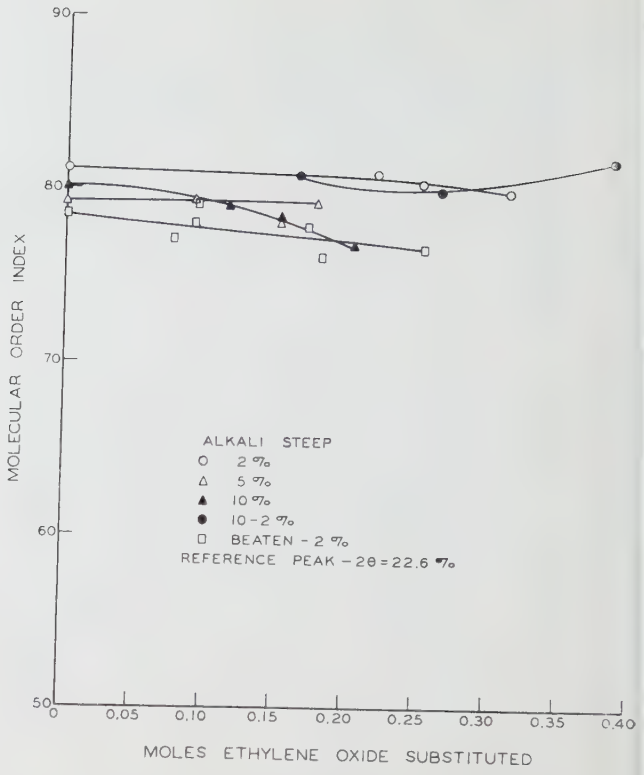


Fig. 5. Molecular order index of hydroxyethylated cotton linters retaining the cellulose I structure

an angle $2\theta = 20.0°$, while the peak from the (101) plane is now evident at slightly below $2\theta = 12°$.

Segal, Creely, Martin, and Conrad (*14*), in a recent publication, proposed an empirical method for estimating the degree of crystallinity of native cellulose. This is represented in Fig. 3. This method compares the intensity of diffraction of the strongest diffracting plane with that of an amorphous background (I_{am}) measured at $2\theta = 18°$. A molecular order index (*MOI*) is calculated using the formula.

$$MOI = \frac{I_{rp} - I_{am}}{I_{rp}} \times 100$$

We have attempted to extend this method, for the purposes of this investigation to include diffractograms of mercerized and partially mercerized cellulose. Because this extension deviates from the careful work done in the Southern Utilization Research and Development Division of the U. S. Department of Agriculture, we have chosen to call the index a molecular order index to distinguish it from the crystallinity index recommended by Segal, and co-workers for use with cellulose I patterns. Figure 3 shows that the background scattering at $2\theta = 18°$ is very close to the 20.0° peak of the cellulose II pattern, and the curve is already sloping upward at the 18° point. To evaluate this effect, a series of diffractograms were obtained using homogenous mechanical mixtures of untreated linters and those treated in 20% alkali, varying the proportions of each. The molecular order indices were calculated for each recognizable peak, to give the results shown in Fig. 4. The indices are compared only where the same reference peak is used for calculation. The top line represents the dilution of cellulose I by cellulose II with a decrease in intensity of the peak at 22.6°. With the cellulose II sample, the 22.6° peak has shifted to 21.5°, and it is only for this reason that the dotted line has been used to connect the last two points. The bottom line represents the increase in concentration of the cellulose II form as measured by the 20.0° peak. Even though this method of analysis leads to values that are not strictly linear with concentration, it does provide a means of detecting the direction of change in molecular order due to a physical or chemical change taking place within the fine structure of the fibers.

This method of analysis was then used to evaluate all of the hydroxyethylated cotton linters samples prepared for this investigation.

RESULTS AND DISCUSSION

Molecular Order Index

The x-ray diffraction results for the samples that retained the cellulose I structure are shown in Fig. 5. The molecular order index is plotted against the moles of ethylene oxide substituted per anhydroglucose unit. It can be seen, first of all, that little change takes place in the molecular order index even at as high a substitution level as 0.40 moles of ethylene oxide. With 10% alkali used for both pretreatment and reaction, the greatest opportunity for swelling and the beginning of mercerization exists. Here the molecular order index seems to drop off with substitution, but whether or not this is significant with these limited data, is a moot question. At least such a change might be expected. With the two-stage steep where 10% alkali was used for pretreatment and only 2% during reaction, very little, if any, change in molecular order index took place. When the fibers were beaten before hydroxyethylation in 2% alkali, the molecular order decreases slightly, but there is considerable dispersion of the

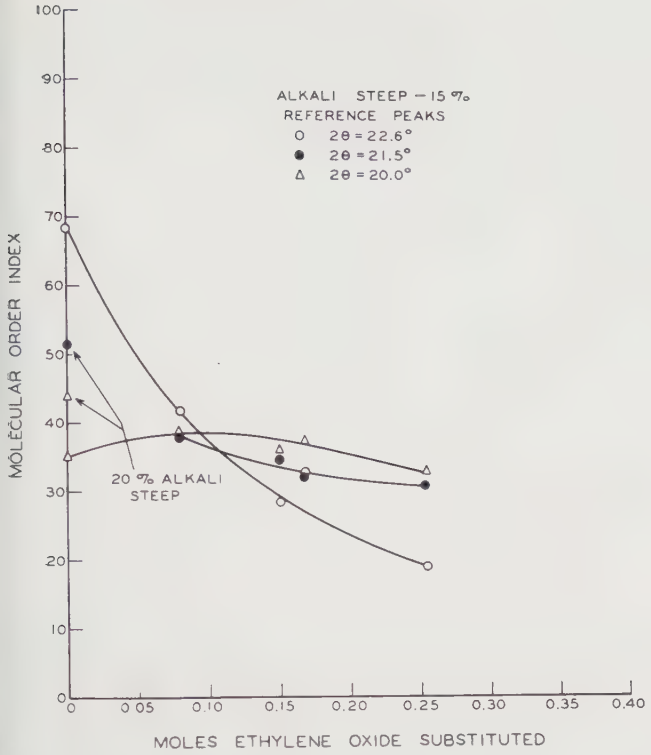


Fig. 6. Molecular order indices of hydroxyethylated cotton linters having a mixed lattice structure

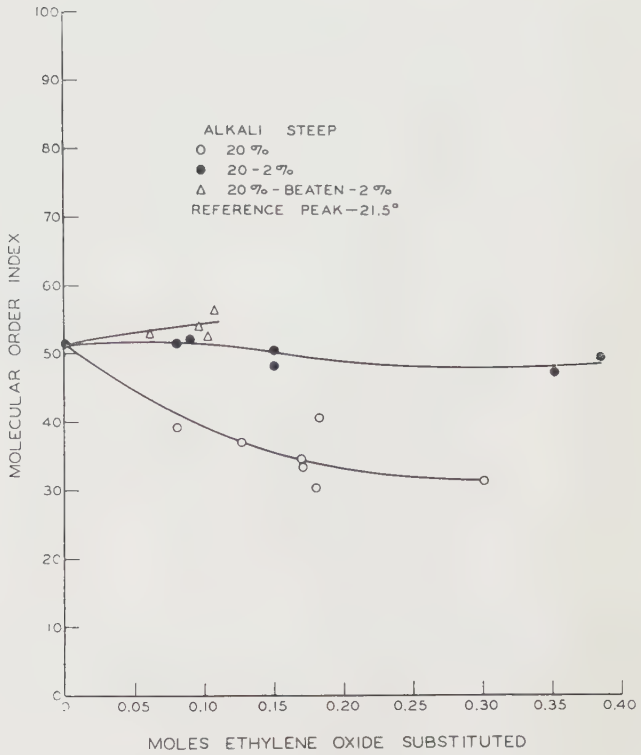


Fig. 7. Molecular order indices of hydroxyethylated cotton linters having the cellulose II structure

points about the line. The molecular order index for the beaten samples was invariably slightly lower than that for the unbeaten fibers. In all of these cases, with the possible exception of the samples prepared with 10% alkali, the ethylene oxide appears to be unable to penetrate the crystal lattice and reduce the molecular order. The substitution remains predominantly in the disordered regions of the fine structure, or upon the surfaces of the crystallites. This will be discussed a little more fully later.

When 15% alkali was used for both the pretreatment and the reaction steps, partial mercerization took place and a mixture of cellulose I and cellulose II resulted. These results are shown in Fig. 6. The molecular order index for the cellulose I peak shows a rapid decline with substitution increase although the peak is still discernible at 0.25 moles of ethylene oxide. The index at 20.0° shows some increase and then a decline. The peak at 21.5° is recognizable at slightly below 0.10 moles of ethylene oxide, and its index decreases as substitution progresses. This would indicate that, under these conditions, the ethylene oxide can penetrate the crystal lattice and assist in shifting the lattice more toward the cellulose II form. Also, the products are more disordered than mercerized cellulose since their molecular order indices are less than those for fibers that have been treated only with mercerizing-strength alkali. The two points for mercerized cellulose are shown in the figure as separate points.

The samples that were mercerized and then hydroxyethylated gave the x-ray diffraction results shown in Fig. 7. The molecular order indices were calculated from the 21.5° reference peak of the cellulose II pattern. When the reaction is carried out in 20% al-

Table II. Solubility of Hydroxyethylated Linters in Sodium Hydroxide at 25°C.

Sample no.	*Alkali steep concn., %*	*M.S.*	*Solubility in NaOH, %*						
			2.0N	*2.5N*	*2.75N*	*3.0N*	*3.5N*	*3.75N*	*4.25N*
C-5	5	0	2.5	1.7	1.6	1.1	1.4		
1		0.090	2.5	4.1	5.1	4.3	3.6		
2		0.150	2.7	3.5	3.5	4.0	3.9		
3		0.176	2.1	2.5	3.5	3.9	3.8		
C-10	10	0	1.4	1.8	2.0	1.5	1.9		
4		0.115	2.5	2.8	2.8	3.4	3.5		
5		0.149	2.5	3.5	4.7	5.8	6.0		
6		0.202	2.6	4.0	6.8	5.3	7.8		
C-15	15	0	1.7	1.9	1.9	1.9	2.1		
7		0.079	4.6	7.9	7.9	6.5	3.7		
8		0.152	29.8	48.2	48.1	39.0	29.6		
9		0.168	60.7	66.9	66.7	67.7	55.0		
10		0.255	73.1	77.9	77.1	82.8	78.8		
C-20	20	0	1.3	1.0	1.1	1.3	1.5		
11		0.080	4.5	6.5	6.1	5.1	3.0		
12		0.127	19.7	36.4	30.3	22.6	12.2		
13		0.179	64.2	86.9	86.4	68.6	42.4		
14		0.301	86.9	83.2	95.1	92.6	98.1		
15	20-2	0.152	2.5	4.2	4.2	8.1	10.3	9.0	5.3
16		0.352	2.6	5.5	7.2	8.7	42.0	24.1	12.3
17		0.386	2.8	5.5	13.1	10.6	23.8	25.4	12.3

Table III. Solubility of Hydroxyethylated Linters in Sodium Hydroxide at 3°C.

Sample no.	Alkali steep concn., %	M.S.	Solubility in NaOH, % 2.0N	2.5N	2.75N	3.0N	3.5N	3.75N	4.25N
C-5	5	0	3.2	4.2	3.1	3.6	3.6		
1		0.090	5.1	14.3	16.0	19.1	11.4		
2		0.150	4.2	11.3	15.3	15.2	11.2		
3		0.176	3.3	12.0	16.3	21.3	10.6		
C-10	10	0	1.5	2.1	3.2	3.2	2.5		
4		0.115	2.8	9.0	14.9	14.9	8.4		
5		0.149	3.3	8.3	12.3	14.4	10.3		
6		0.202	3.3	9.5	17.6	12.8	14.0		
C-15	15	0	1.7	2.2	3.1	4.1	2.2		
7		0.079	8.5	14.7	15.0	17.4	8.4		
8		0.152	42.3	68.7	72.4	88.0	84.9		
9		0.168	63.6	81.3	92.0	92.5	70.0		
10		0.255	76.6	75.2	81.5	89.2	88.0		
C-20	20	0	1.5	1.7	2.0	2.0	1.8		
11		0.080	16.4	21.4	18.1	19.2	11.4		
12		0.127	23.3	63.7	54.2	27.5	12.0		
13		0.179	94.3	97.3	95.1	91.0	95.3		
14		0.301	86.3	88.8	92.4	93.1	86.5		
15	20-2	0.152	5.3	20.9	28.7	63.1	33.7	21.8	10.0
16		0.352	7.6	12.6	39.7	87.7	75.0	57.3	23.6
17		0.386	6.4	15.1	13.4	46.9	74.9	70.0	23.9

kali, molecular order decreases with increasing substitution. Here again the ethylene oxide appears to penetrate into the crystallite areas of the fine structure quite readily. On the other hand, when mercerized cellulose is hydroxyethylated in the presence of only 2% alkali, little change in molecular order resulted. Apparently, the crystallite regions must be in a highly swollen condition before penetration by ethylene oxide can occur with any ease. When mercerized cellulose is beaten before reaction with ethylene oxide in 2% alkali, the molecular order index remains high and may even increase slightly.

Alkali Solubility

The solubility behavior of many of these samples was determined in a range of sodium hydroxide concentration from 2.0 to 4.25*N*. Exploratory experiments indicate that a solubility maximum occurs between these values and that only slight solubility takes place at concentrations as low as 0.05*N*. The results of these determinations are shown at 25°C. in Table II and at 3°C. in Table III. Each value represents the average of four determinations—duplicate analytical data on each of two separate samples. The samples that retained the cellulose I crystal lattice pattern, those that were treated in 2, 5, and 10% alkali, exhibited only low solubility under any of the conditions evaluated. Representative of these results are those shown in Fig. 8 for the solubility at 3°C. of the samples hydroxyethylated after a 5% alkali steep. The solubility is plotted as a function of the concentration of the sodium hydroxide used in the determination. Each sample exhibited a maximum solubility at a particular alkali concentration. The data were insufficient to allow this point to be determined with accuracy for any particular sample. The smooth curves shown in the figures can be considered only as gross approximations. In most cases the solubility maximum occurs at a concentration of about 2.75 to 3.0*N*. The results in Fig. 8 show this maximum to be at about 3.0*N* or possibly slightly higher. The effect of increasing substitution is to increase solubility, and this difference is greatest at the point of maximum solubility. The alkali concentration required for maximum solubility is approximately the same at either 25°C. or 3°C. The solubility level is higher at the lower temperature as expected.

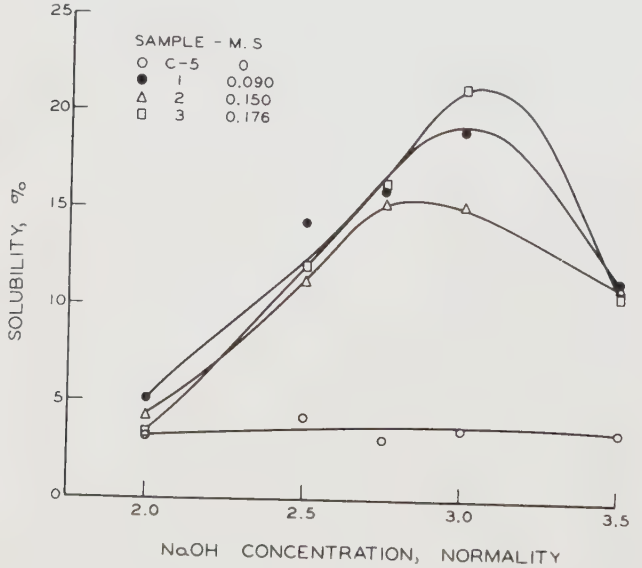


Fig. 8. Solubility at 3°C. of cotton linters hydroxyethylated after a 5% alkali steep

The mercerized samples that had been hydroxyethylated with only 2% alkali and that had retained a high degree of molecular order also exhibits a rather sharp solubility maximum. These results are shown in Fig. 9. Because of the higher solubility shown by these samples, the solubility scale has been reduced in this plot. The solubility of these samples changes quite rapidly over a fairly narrow range of alkali concentration. This is due, apparently, to the fact that the hydroxyethylation reaction does not reduce the original molecular order of the cellulose chains to any great extent. A certain minimum concentration of sodium hydroxide is required to swell the crystallites before any appreciable solubility can occur. This is borne out further upon comparison with the solubility behavior of samples that had lost molecular order during the reaction with ethylene oxide. Typical results are shown in Fig. 10 for the samples prepared with 15% alkali. These results were obtained at 25°C. because the solubility is so high at 3°C. that differences are difficult to detect. These samples show less sensitivity to a change in concentration of the sodium hydroxide

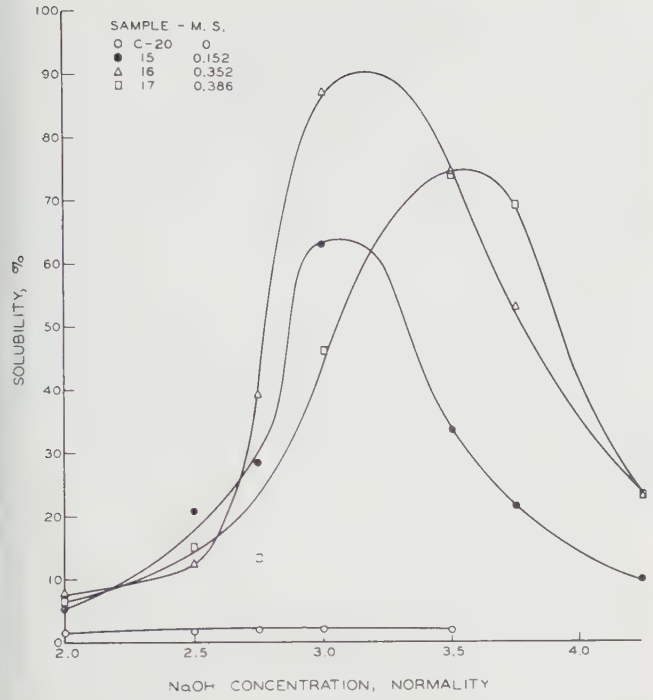


Fig. 9. Solubility at 3°C. of cotton linters hydroxyethylated in two stages: 20% NaOH, neutralization, 2% NaOH

test solution. This was interpreted to be the result of the lower degree of molecular order that exist in these samples. As expected, the increase in substitution level gives a progressive increase in solubility.

Some of these effects are shown more clearly by plotting the solubilities obtained at a single alkali concentration as a function of their substitution values.

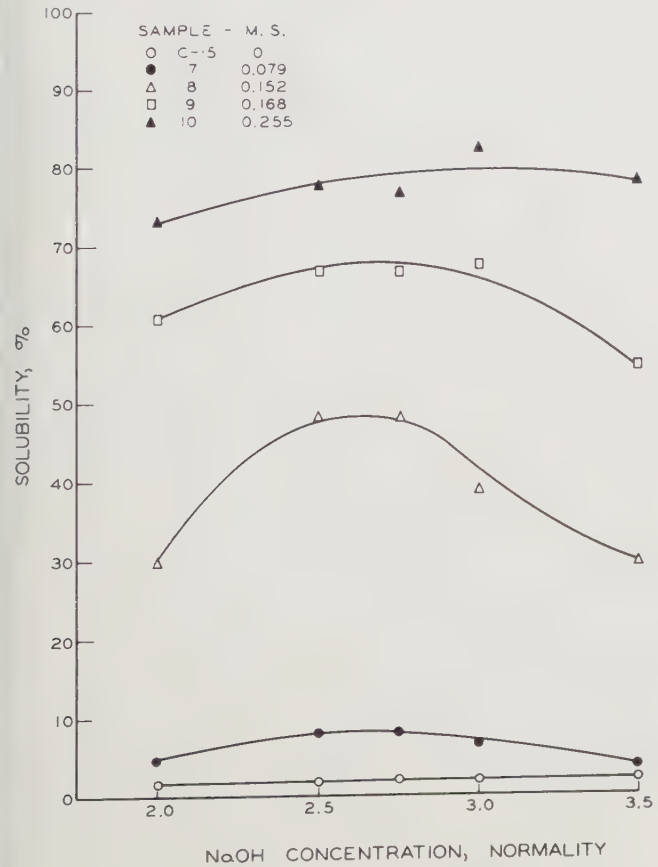


Fig. 10. Solubility at 25°C. of cotton linters hydroxyethylated after a 15% alkali steep

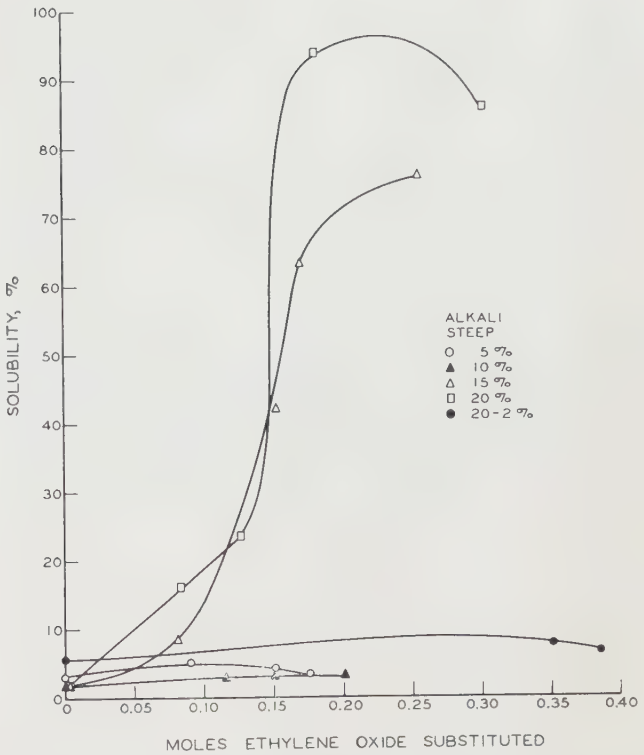


Fig. 11. The effect of substitution level of hydroxyethylated cotton linters on the solubility in 2.0N NaOH at 3°C.

Figure 11 shows the effect of substitution on the solubility behavior in 2.0*N* alkali at 3°C. This concentration of alkali appears to separate the samples into two groups. The samples which show low solubility are those that have retained the molecular order of the cellulose chains to a large extent during the substitution reaction. Both mercerized and unmercerized samples appear in this group. Those with a high

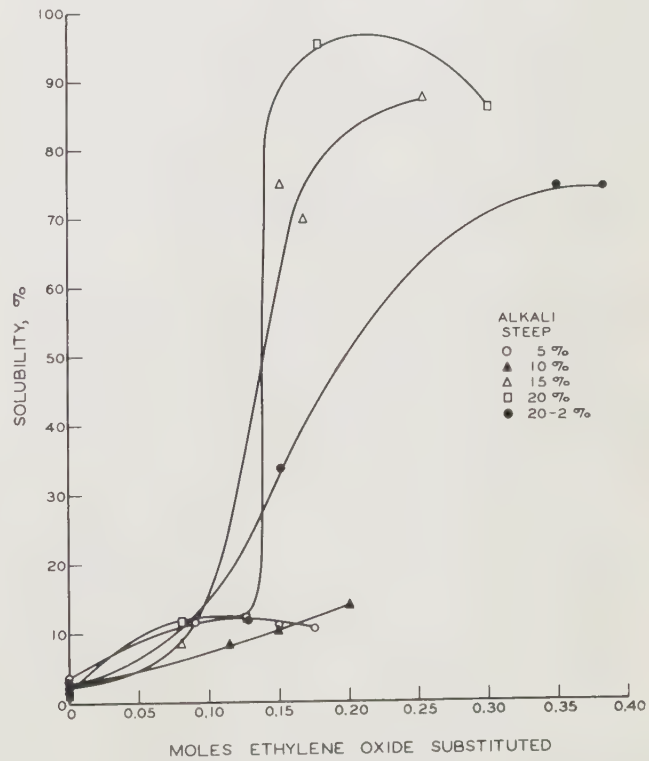


Fig. 12. The effect of substitution level of hydroxyethylated cotton linters on the solubility in 3.5N NaOH at 3°C.

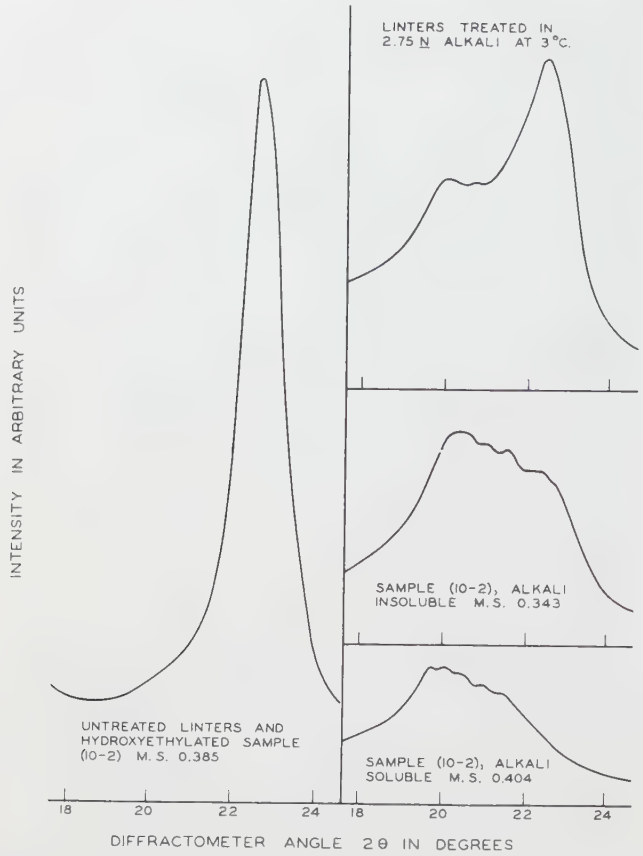


Fig. 13. Diffractometer tracings of an hydroxyethylated cotton linters sample after extraction with 2.75N NaOH

solubility have lost their molecular order, to varying degrees, during the substitution reaction. These samples show a very rapid increase in solubility as soon as the level of substitution reaches 0.10 moles of ethylene oxide. This same rapid increase in solubility was noted when 3.5*N* alkali was used. These results are shown in Fig. 12. Here again, the samples seem to be separated into two groups, but the differences now appear to be associated with changes due to mercerization. The samples of high solubility are those that were partially or completely mercerized during their preparation. The samples of low solubility are those with the crystal lattice pattern of cellulose I.

Fractionation by Solution

These results suggested that some fractionation might be achieved if samples were extracted with alkali of a concentration close to the maximum solubility point. One sample was fractionated with the results shown on Fig. 13. The sample chosen for this attempt at separation was one that had been hydroxyethylated by a two-stage steep, pretreatment in 10% alkali, and reaction in 2% alkali. The substitution level was high, 0.385 M.S. On the other hand, its x-ray diffraction pattern was that of a high degree of order as cellulose I and identical to that of the untreated linters. Alkali of 2.75*N* was used for the extraction at 3°C. Under these conditions, the untreated linters become partially mercerized, and their x-ray diffraction tracing is shown in the upper right-hand corner of Fig. 13. When the hydroxyethylated sample was subjected to the same conditions for three extractions, 96% of the sample was recovered of which 60% is alkali insoluble and 40% is soluble. The x-ray diffraction tracings for these two samples are shown in the lower right-hand corner of Fig. 13. The presence of the hydroxyethyl groups within the fine structure of the fibers allows the alkali to exert a much greater influence on the molecular order than when these substituents are absent. This occurs even though the substituent groups cannot be detected by x-ray diffraction in the original sample. The tracings of the alkali-treated samples show a broad maximum with ill-defined peaks that are more like cellulose II than cellulose I. The alkali-soluble fraction is more disordered than is the insoluble fraction since the peak intensity is much less. Actually, both fractions contain hydroxyethylated cellulose chains with only minor separation having taken place. The alkali-soluble fraction is enriched slightly, but only to an M.S. of 0.404, while the insoluble fraction still retains an M.S. of 0.343. It has been postulated that the ethylene oxide does not enter the highly ordered regions of the fine structure of the fiber in this case. However, many of the cellulose chains in these regions may become hydroxyethylated on the surfaces of the crystallites or where the chains extend into more disordered regions. Such chains cannot be extracted by alkali, since the crystallite regions only will be swollen by the alkaline extraction. In the swollen state, the mobility of the chains, or at least portions of the chains, allows for a realignment of the cellulose molecules. The original degree of order of the cellulose chains cannot be realized, upon removal of the swelling medium, because of the steric influence of the hydroxyethyl groups. It would be anticipated that further work of this nature would lead to some additional and interesting conclusions.

CONCLUSIONS

It has been demonstrated that a wide variety of hydroxyethylated fibrous products can be prepared from cotton linters by regulating the conditions used for pretreatment and for reacting with ethylene oxide. The type of crystal lattice that exists in the final product can be controlled. A substitution level of as high as 0.4 moles of ethylene oxide per anhydroglucose unit could be achieved without appreciable change in the molecular order of the cellulose chains. The upper limit of substitution without causing a material loss of molecular order was not reached during the present investigation. When the fibers were hydroxyethylated in a highly swollen condition, molecular order was reduced. Under these conditions, the highest rate of reaction also occured due to the catalytic effect of the high concentration of alkali. Even under these conditions, the rate of diffusion of ethylene oxide into the fiber does not appear to be a factor. The ethylene oxide can penetrate the fine structure with ease even though a rapid rate of reaction takes place. The reaction is not confined just to the surface of the fibers under any of the conditions used. It is concluded that hydroxyethylated cotton linters fibers can be prepared that vary widely in their chemical and physical properties, depending upon the control that is exercised upon the reaction conditions employed.

LITERATURE CITED

1. Bletzinger, J. C., *Ind. Eng. Chem.* 35: 474 (1943).
2. Aiken, W. H., *Ind. Eng. Chem.* 35: 1206 (1943).

3. Harrison, J. J., *Paper Ind.* 26: 388 (1944).
4. Jayme, G. and Froundjian, D., *Cellulosechemie* 18: 9 (1940).
5. Walecka, J. A., *Tappi* 39: 458 (1956).
6. Talwar, K. K., *Tappi* 41: 207 (1958).
7. Harpham, J. A., Reid, A. R., and Turner, H. W., *Tappi* 41: 629, 758 (1958).
8. Spadaro, J. J., Janssen, H. J., Vix, H. L. E., and Simons, F. L., *Tappi* 41: 674 (1958).
9. Ward, K., Jr., *Tappi* 43: 54 (1960).
10. Long, F. A. and Pritchard, J. G., *J. Am. Chem. Soc.* 78: 2663, 2667, 6008 (1956).
11. McKelvey, J. B., Webre, B. G., and Klein, E., *Textile Research J.* 29: 918 (1959).
12. Morgan, P. W., *Ind. Eng. Chem., Anal. Ed.* 13: 500 (1946).
13. The Swedish Association of Pulp and Paper Engineers *Technical Communications* Series CCA.
14. Segal, L., Creely, J. J., Martin, A. E., Jr., and Conrad, C. M., *Textile Research J.* 29: 786 (1959).

Received April 18, 1961. Presented at the 139th Meeting of the American Chemical Society, held in St. Louis, Mo., March 21–30, 1961.

Conditions Influencing the Viscosity Reduction of Cellulose in Its Esterification with Lower Aliphatic Anhydrides

CARL J. MALM, R. E. GLEGG, LEO J. TANGHE and JANET THOMPSON

To understand the factors which influence the breakdown of cellulose acetate, propionate, and butyrate during their manufacture, studies were made with triesters in solution in different esterification mixtures. The effect of the acyl group in the ester and in the solvent was investigated independently and together. With different esters in the same acid-anhydride mixture, viscosity reduction decreases in the order: acetyl, propionyl, *n*-butyryl; with the same ester and different acyl groups in the solvent, the order is reversed. For the esters in their corresponding acid–anhydride mixture, the nature of the catalyst determines the order. As the acid-to-anhydride ratio is changed at constant catalyst concentration, the rate of viscosity reduction changes or not, depending upon the catalyst used. When catalyst concentrations are adjusted to produce equivalent esterification rates with various acid to anhydride ratios and at different temperatures, less viscosity reduction occurs with higher anhydride concentration and lower temperature. These are the esterification conditions for the economical manufacture of high-viscosity cellulose propionates and butyrates. The effective anhydride concentration can be increased by keeping the amount of aliphatic acid at a minimum.

When cellulose is esterified it first undergoes heterogeneous reactions of simultaneous esterification and viscosity reduction. As the triester is formed it goes into solution, and viscosity reduction continues after the esterification is completed. During the esterification many factors influence viscosity reduction; these include the degree of substitution and the rate of diffusion of reagents. To avoid these variables, experiments were designed to study the viscosity reduction of fully esterified cellulose esters after the solution had been formed. The amount of viscosity reduction of the ester in solution can be affected by its original viscosity, the temperature, the nature and concentration of the catalyst, the type and concentration of anhydride, the liquid-to-solid ratio, and the acyl groups in the solvent and ester.

Viscosity reduction was determined from the intrinsic viscosity of the ester in 90% methylene chloride–10% methanol and from that of the regenerated cellulose in iron-sodium tartrate. In addition, a simpler method was used in which the viscosities of the reaction mixtures were measured.

Carl J. Malm, R. E. Glegg, Leo J. Tanghe, Janet Thompson, Cellulose Technology Division, Eastman Kodak Co., Rochester, N. Y.

Experiments were devised so that the contribution of each variable could be evaluated separately. This paper describes the effects of each of these factors on viscosity reduction and shows how this information can be used to understand and design commercial processes for manufacturing cellulose esters.

MATERIALS AND METHODS

Cellulose Esters. A few of the esters were regular commercial products, but most were made especially for this study. They were analyzed for acyl groups by the partition method (*2*), for total hydroxyl by carbanilation (*5*), and for primary hydroxyl by tritylation (*5*).

Solvents. The components of all solvents were freshly distilled. Mixtures of acetic, propionic, and butyric acids with the corresponding anhydrides were refluxed or allowed to stand a few days to remove small amounts of water. All concentrations are by weight.

Ester Solutions. All esters were dried at 110°C. for 2 hr. Solutions were made just prior to use by vigorously stirring the dry ester and the solvent. In all cases the ester dissolved quickly enough so that there was no change in composition or viscosity before the reaction was started by the addition of catalyst.

The weight of each ester to be dissolved was calculated from its composition, to provide equivalent concentrations on a cellulose basis in each experimental series. This amounted to 40–50 g. of ester per 1000 g. of solvent.

Catalysts. Perchloric, methanesulfonic, and sulfoacetic acids were used in this study because they are noncombining catalysts. Variations due to differences in the amount of catalyst combined with the cellulose were thus avoided.

A stock solution of 5*M* perchloric acid was prepared by diluting 176.2 g. of reagent-grade acid (71.3% $HClO_4$) to 250 ml. with glacial acetic acid. Four milliliters of this solution per 100 g. of ester solution gave a final perchloric acid concentration of approximately 0.2 molal. In all other cases stock solutions were diluted so that 1 ml. per 100 g. of ester solution gave the required molal concentration. Methanesulfonic acid was redistilled at 132°C. at 1 mm. and was not diluted before use.

Table I. Analyses of Cellulose Esters Used in Determining Effect of Acyl Group on Viscosity Reduction[a]

	Acetate	Propionate	Butyrate
Intrinsic viscosity of regenerated cellulose in iron-sodium tartrate, dl./g.	2.54	2.56	2.50
Total hydroxyl, weight %	3.71[b]	0.28	0.33
Degree of substitution	2.42	2.95	2.93

[a] Figures 1–9.
[b] The ester contained 0.05% total hydroxyl when isolated 3 min. after adding the catalyst.

In some experiments viscosity reduction was compared at equimolal catalyst concentrations, at various temperatures and in different solvents. In other experiments viscosity changes were studied at catalyst concentrations experimentally determined to give equivalent esterification rates. Changes in total hydroxyl content of the ester, determined by carbanilation (*5*), were used to measure the rate of esterification. The final reaction mixtures, from which samples were isolated for this purpose, were held at the same temperature for later study of viscosity reduction.

Temperature. Unless stated otherwise, the reactions were studied at 25°C.

Precipitation, Washing, and Drying. Esters were precipitated into distilled water from 90% acetic acid–10% acetic anhydride, 50% acetic acid–50% acetic anhydride, and 90% propionic acid–10% propionic anhydride. Samples were precipitated into 20% acetic acid from acetic anhydride and 15% acetic acid–85% acetic anhydride. All other samples were precipitated into hexane, washed once with a mixture of equal volumes of water and denatured ethyl alcohol (5% methyl alcohol), and once with distilled water, then dissolved in acetone and reprecipitated in distilled water.

Precipitated samples were washed with distilled water, then once in slightly alkaline water (by adding small amounts of sodium carbonate to obtain a permanent pink color with phenolphthalein), and finally in distilled water. The samples were squeezed as dry as possible, dried overnight at 50°C., then in the vacuum of a water aspirator for 3 hr. at 50°C.

Regeneration of Cellulose from Esters. Cellulose was regenerated from cellulose esters with 0.5*N* sodium methylate in anhydrous methanol (*4*). The method is described below. If the ester is hard or horny it should be redissolved and precipitated in a more fluffy form. The ester should not be ground, because grinding may reduce the viscosity.

The reagent is prepared by dissolving 27 g. of sodium methylate in 1 liter of anhydrous methanol (or by using the appropriate amount of metallic sodium). One gram of the ester and 100 ml. of the reagent are placed in a 4-oz. screw-cap bottle and tumbled overnight, or allowed to stand for 24 hr. with occasional shaking, at room temperature.

The regenerated cellulose is filtered off on a Büchner funnel, washed twice was distilled water, once with 1% acetic acid, and finally with distilled water. During each wash the suction is disconnected for about 1 min. before pulling the liquid through. The cellulose is returned to the bottle, 100 ml. of water added, and the mixture shaken for a few minutes; one drop of phenolphthalein indicator is added, followed by enough 1% sodium carbonate solution to produce a permanent faint pink color. The cellulose is filtered off, washed once with distilled water, once with methanol, then dried for 4 hr. in a vacuum oven at 50°C. The theoretical amount of cellulose can be recovered.

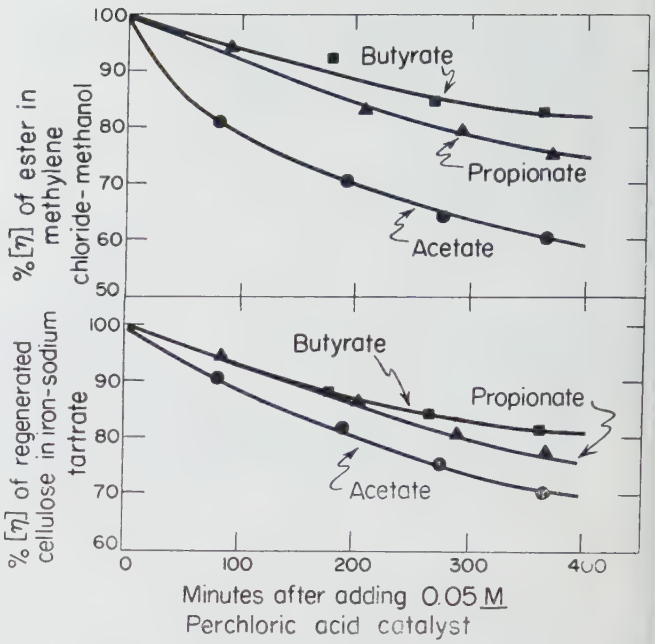


Fig. 1. Effect of acyl group in cellulose esters on viscosity reduction in acetic acid–acetic anhydride

Methods of Measuring Viscosity

The intrinsic viscosity of the ester was determined in 90% methylene chloride–10% methanol by weight. The intrinsic viscosity in iron–sodium tartrate was measured on samples of cellulose regenerated from the esters. Iron–sodium tartrate solution was prepared by the method of Valtasaari (*6*); but 35 g.p.l. sodium tartrate was used for stabilizing the solution instead of the recommended amount (5 g.p.l.).

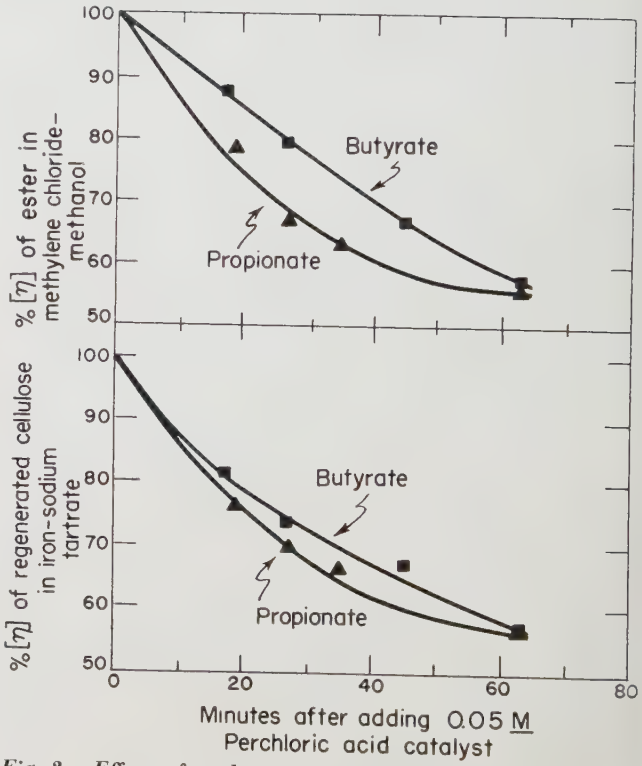


Fig. 2. Effect of acyl group in cellulose esters on viscosity reduction in propionic acid–propionic anhydride

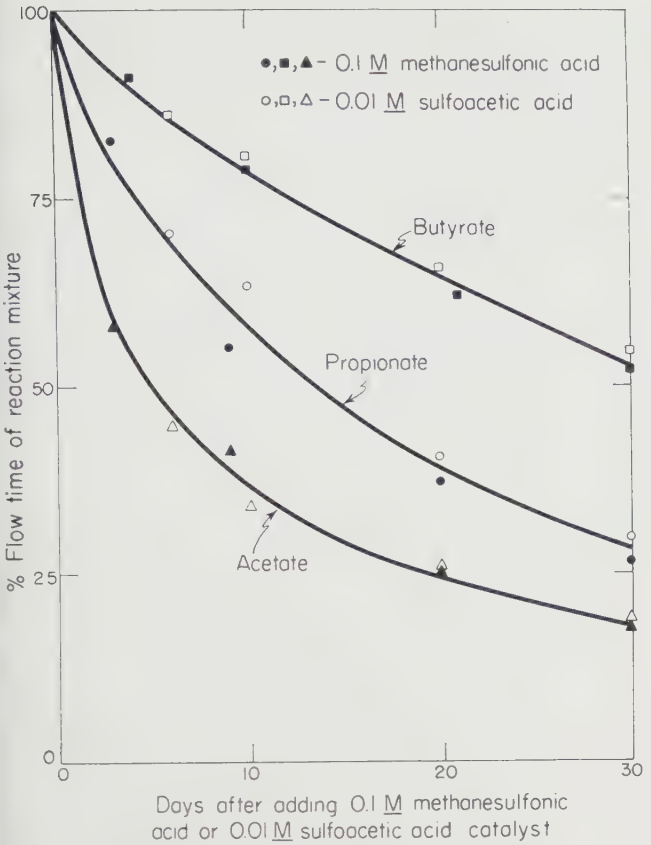

●,■,▲ – 0.1 M methanesulfonic acid
○,□,△ – 0.01 M sulfoacetic acid
Butyrate
Propionate
Acetate
% Flow time of reaction mixture
Days after adding 0.1 M methanesulfonic acid or 0.01 M sulfoacetic acid catalyst

Fig. 3. Effect of acyl group in cellulose esters on viscosity reduction in acetic acid–acetic anhydride

A simple method of following the reduction in viscosity of the esters involved measuring the flow time of 10 ml. of the reaction mixture in an Ostwald-Cannon-Fenske viscometer at 25°C. Changes in viscosity of the solution were used to decide when to isolate samples by precipitation. The trends shown by these changes always corresponded with those obtained by viscosity measurements on the precipitated samples (*3*). All three methods are used to show the results.

EXPERIMENTAL

Viscosity changes are expressed as percentage of the original viscosity remaining at any time. It is well known that cleavage of primary bonds in a polymer of higher molecular weight gives a larger percentage reduction in viscosity than the same breakage in a corresponding product of lower molecular weight. To avoid the effect of the original viscosity, esters were chosen with the same initial viscosity on a cellulose basis for each experimental series.

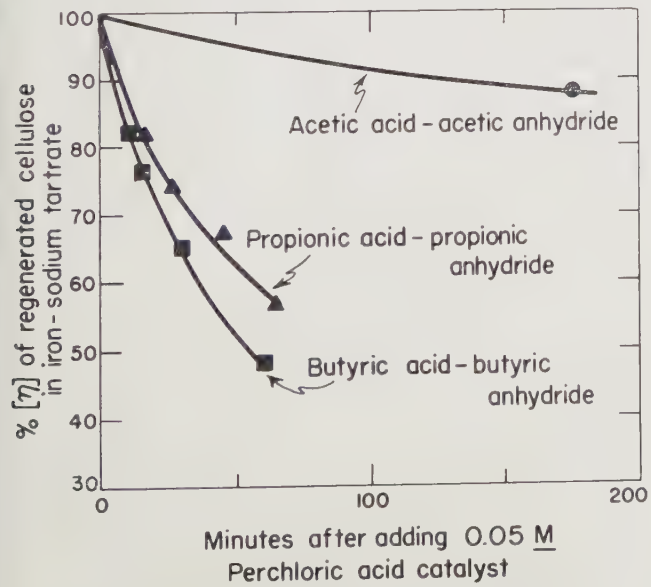

Acetic acid – acetic anhydride
Propionic acid – propionic anhydride
Butyric acid – butyric anhydride
% [η] of regenerated cellulose in iron-sodium tartrate
Minutes after adding 0.05 M Perchloric acid catalyst

Fig. 4. Effect of acyl group in acid–anhydride mixtures on viscosity reduction of a cellulose butyrate

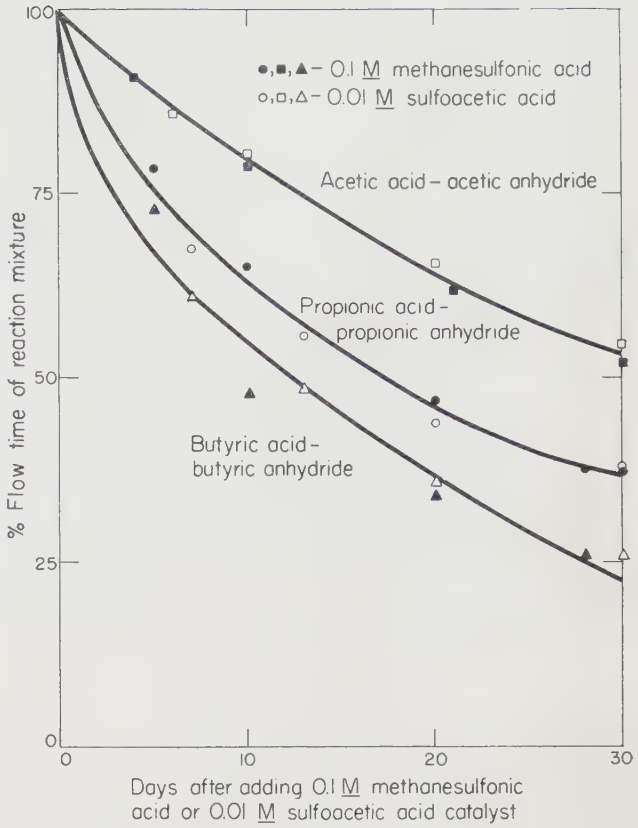

●,■,▲ – 0.1 M methanesulfonic acid
○,□,△ – 0.01 M sulfoacetic acid
Acetic acid – acetic anhydride
Propionic acid – propionic anhydride
Butyric acid – butyric anhydride
% Flow time of reaction mixture
Days after adding 0.1 M methanesulfonic acid or 0.01 M sulfoacetic acid catalyst

Fig. 5. Effect of acyl group in acid–anhydride mixtures on viscosity reduction of a cellulose butyrate

A. Effect of Acyl Group in the Cellulose Ester

Samples of cellulose acetate, propionate, and butyrate (Table I) were made from cotton linters with sulfuric acid catalyst, but were substantially free from combined sulfuric acid. The viscosity reduction was studied with perchloric acid catalyst at 25°C. in 90% acetic acid–10% acetic anhydride by weight (Fig. 1), in 90% propionic acid–10% propionic anhydride (Fig. 2), and in 50% acetic acid–50% acetic anhydride.

To exclude any effects due to degree of substitution, the ideal samples should all be triesters. However, the triacetate could not be dissolved directly in these solvents. The final choice involved esters which were as highly substituted as possible and still soluble in the acid-anhydride mixtures (Table I). Since 0.152 mole of ester was dissolved in 1 kg. of acid–anhydride mixture, there was a large excess of anhydride; in combination with a high perchloric acid catalyst concentration (0.05*M*), the esters were fully esterified in a few minutes. For example, the acetate (Table I) contained only 0.05% total hydroxyl 3 min. after adding the catalyst; the viscosity had not changed significantly in this time—the intrinsic viscosity of the regenerated cellulose in iron–sodium tartrate was 2.45 dl./g. Under these conditions the possible effect of degree of substitution was avoided; this is true in all experimental series.

Viscosity was measured on the precipitated esters in 90% methylene chloride 10% methanol and on the regenerated cellulose from these esters in iron–sodium tartrate. The two methods showed the same trends. In 90% acetic acid–10% acetic anhydride with 0.05*M* perchloric acid catalyst (Fig. 1), the rate of viscosity reduction increased in the order: butyrate, propionate, acetate. This same order was observed in 50% acetic acid–50% acetic anhydride with 0.05, 0.1, and 0.2*M* perchloric acid.

The same propionate and butyrate were studied in 90% propionic acid–10% propionic anhydride (Fig. 2), but the acetate was not soluble in this solvent. As before, the reduction in viscosity of the propionate was at least initially faster than that of the butyrate.

A similar effect of acyl group in the ester was found when the catalysts were sulfoacetic acid and methanesulfonic acid in 90% acetic acid–10% acetic anhydride (Fig. 3). In this case viscosity was measured as the flow times of the reaction mixtures. The smaller the molecular weight of the acyl substituent in the homologous series studied, the faster is the rate of viscosity reduction.

B. Effect of Acyl Group in the Acid–Anhydride Mixture

The results with a cellulose propionate showed that viscosity reduction took place faster in propionic acid–propionic anhydride (Fig. 2) than in acetic acid–acetic anhydride (Fig. 1). When the reaction was run in propionic acid–propionic anhydride, the intrinsic viscosity in iron sodium tartrate of the regenerated cellulose decreased to 80% of the original value in 15 min. (Fig. 2); the same change in acetic acid–acetic anhydride required 300 min. (Fig. 1).

A study of the effect of acid–anhydride mixtures was therefore extended to 90% butyric acid–10% butyric anhydride (Figs. 4 and 5). The ester was a cellulose butyrate (Table I). With all three catalysts, viscosity reduction in butyric acid–butyric anhydride was faster than in propionic acid–propionic anhyride, in which, in turn, it was faster than in acetic acid–acetic anhydride. The effect of the acid–anhydride combination is probably due, in part, to differences in acidity function on passing from acetic acid to its higher homologues.

In making cellulose acetate, propionate, and butyrate, from cellulose, viscosity reduction takes place in the corresponding acid–anhydride solvent. At the beginning of the esterification there are no acyl groups to protect the cellulose, and in addition, viscosity reduction increases with an increase in the molecular weight of the acid–anhydride system. The higher anhydride has lower reactivity, so for a given amount of catalyst the protection of the cellulose by esterification would be slower than with a lower anhydride.

The present work shows that toward the end of the esterification opposing forces influence the rates of viscosity reduction. The higher molecular weight acyl group in the cellulose ester tends to minimize the loss in viscosity (Figs. 1–3), while the same group in the acid–anhydride mixture accelerates the reduction of viscosity (Figs. 4 and 5). This is true for perchloric, methane-sulfonic, and sulfoacetic acids as catalysts.

Table II. Concentrations of Sulfoacetic and Methanesulfonic Acid Catalysts Required for Equivalent Esterification Rates[a]

Esterification mixture	*Anhydride, weight %*	*Sulfoacetic acid, M*	*Methanesulfonic acid, M*
Acetic	10	0.02	0.12
	50	0.0014	0.02
Propionic	10	0.085	0.37
	50	0.01	0.14
Butyric	10	0.055	0.26
	50	0.019	0.18

[a] The original cellulose acetate butyrate contained 0.54 OH per glucose unit (OH/g.u.). Esterification rates were the same in each case—0.15 OH/g.u. after 20 min.; 0.13 after 30 min.; 0.09 after 60 min.; 0.06 after 120 min. Viscosity reduction is shown in Figs. 8 and 9.

C. Combined Effect of Same Acyl Group in Ester and Acid–Anhydride Mixture

For this study an acetate, propionate and butyrate (Table I) were compared in their corresponding acid-anhydride mixtures. Catalyst concentrations were equimolal. The final result of the two opposing effects described in section B depends on the experimental conditions, especially the catalyst (Figs. 6 and 7). With perchloric acid catalyst (Fig. 6), the effect of the solvent is stronger than that of the acyl group in the ester, so cellulose butyrate loses viscosity in butyric acid–butyric anhydride more rapidly than cellulose acetate in acetic acid -acetic anhydride; cellulose propionate in propionic acid–propionic anhydride takes an intermediate position. The total effect is reversed when the catalysts are methanesulfonic or sulfoacetic acids (Fig. 7), so that the cellulose butyrate in butyric acid–butiric anhydride loses viscosity more slowly than the acetate in acetic acid–acetic anhydride.

With the same acyl group in the ester and acid-anhydride mixture, the relative rate of viscosity reduction varies with the catalysts.

D. Viscosity Reduction of Cellulose Esters in Corresponding Acid–Anhydride Systems at Equivalent Esterification Rates

Viscosity reduction (Figs. 8 and 9) was studied at catalyst concentrations required to give the same esterification rate for an acetate in acetic acid–acetic anhydride, a propionate in propionic acid–propionic anhydride, and a butyrate in butyric acid–butyric anhydride (Table II). The catalysts were sulfoacetic acid and methanesulfonic acid, and the reactions were studied in 90% acid–10% anhydride (Fig. 8) and 50% acid–50% anhydride (Fig. 9).

The catalyst concentrations for equivalent esterification rates (Table II) were determined experimentally in the six solvent systems using a cellulose acetate butyrate which contains 3.12% total hydroxyl, 19.3% acetyl, and 27.1% butyryl; this ester was chosen because of its solubility in a wide range of acid–anhydride mixtures. These catalyst concentrations were then used for viscosity studies on the acetate, propionate, and butyrate in their corresponding acid-anhydride systems; these three esters had the same average chain length—intrinsic viscosity of the regenerated cellulose was 2.5 dl./g. in iron–sodium tartrate (Table I).

This experimental approach was justified by the fact that a cellulose acetate and the cellulose acetate

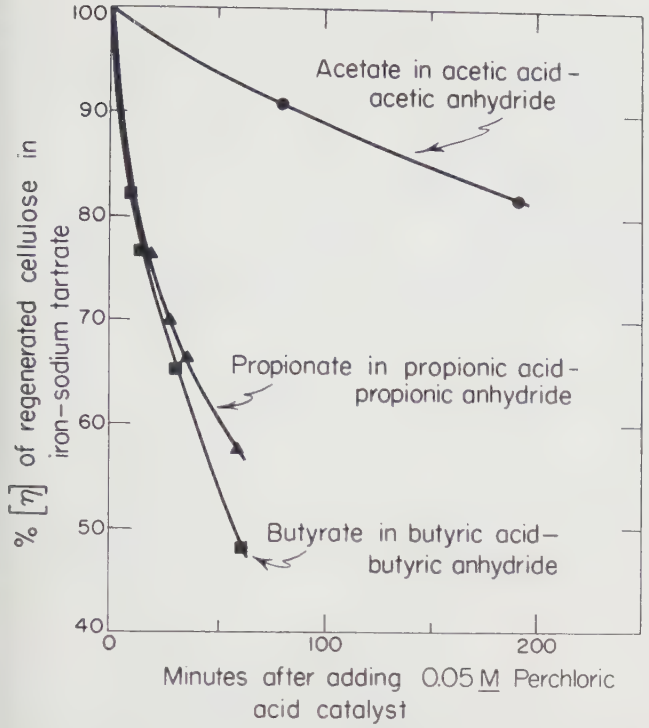

Acetate in acetic acid - acetic anhydride
Propionate in propionic acid - propionic anhydride
Butyrate in butyric acid - butyric anhydride
% [η] of regenerated cellulose in iron-sodium tartrate
Minutes after adding 0.05 M Perchloric acid catalyst

Fig. 6. Viscosity reduction of cellulose esters in corresponding acid–anhydride mixture

butyrate gave equivalent acetylation rates in 90% acetic acid–10% acetic anhydride for the same molal concentration of catalyst; this was true for both catalysts. The same result was obtained when the cellulose acetate butyrate and a cellulose butyrate were compared in 90% butyric acid–10% butyric anhydride. The three esters compared in this section of the work contained the same total hydroxyl (0.54 OH/glucose unit) and primary hydroxyl (0.22 OH/glucose unit).

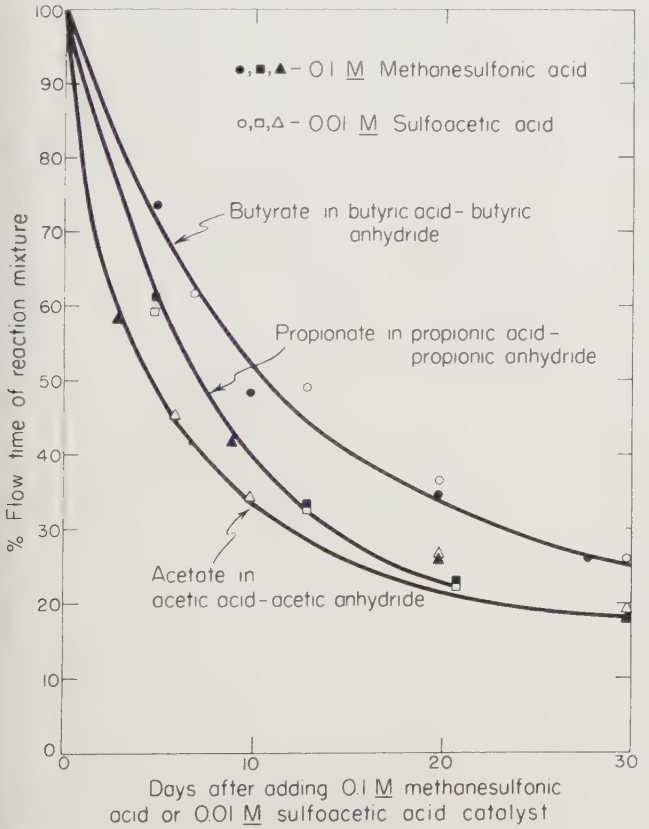

●,■,▲ - 0.1 M Methanesulfonic acid
○,□,△ - 0.01 M Sulfoacetic acid
Butyrate in butyric acid - butyric anhydride
Propionate in propionic acid - propionic anhydride
Acetate in acetic acid - acetic anhydride
% Flow time of reaction mixture
Days after adding 0.1 M methanesulfonic acid or 0.01 M sulfoacetic acid catalyst

Fig. 7. Viscosity reduction of cellulose esters in corresponding acid–anhydride mixture

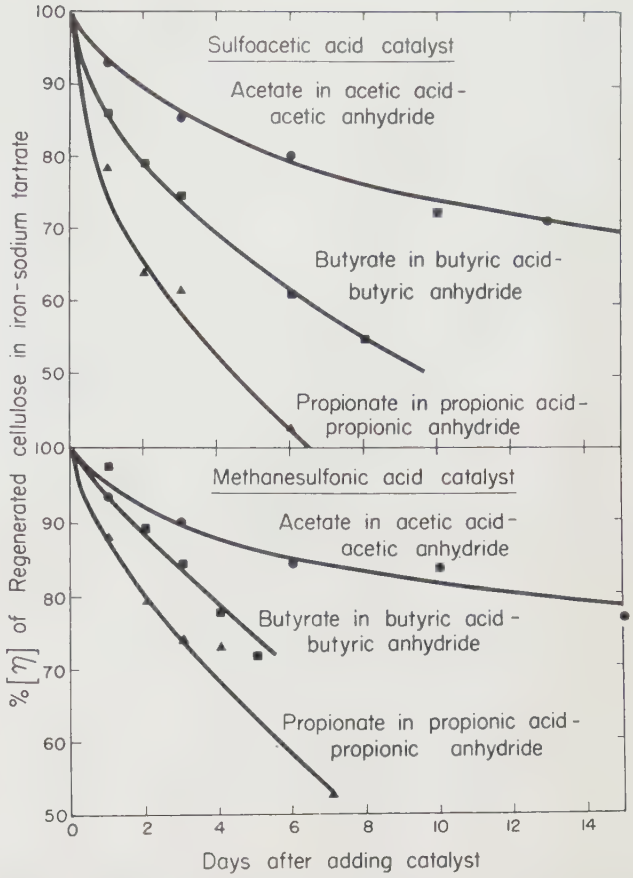

Sulfoacetic acid catalyst
Acetate in acetic acid - acetic anhydride
Butyrate in butyric acid - butyric anhydride
Propionate in propionic acid - propionic anhydride
Methanesulfonic acid catalyst
Acetate in acetic acid - acetic anhydride
Butyrate in butyric acid - butyric anhydride
Propionate in propionic acid - propionic anhydride
% [η] of Regenerated cellulose in iron-sodium tartrate
Days after adding catalyst

Fig. 8. Viscosity reduction of cellulose esters in corresponding 90% acid–10% anhydride mixture at equivalent esterification rates

In 90% acid–10% anhydride (Fig. 8) cellulose acetate in acetic acid–acetic anhydride loses viscosity slower than the butyrate in butyric acid–butyric anhydride,

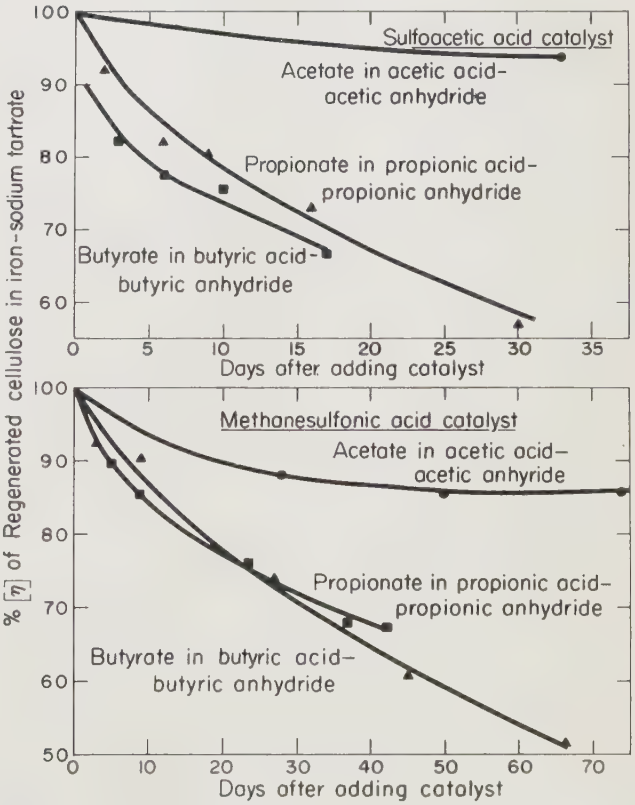

Sulfoacetic acid catalyst
Acetate in acetic acid - acetic anhydride
Propionate in propionic acid - propionic anhydride
Butyrate in butyric acid - butyric anhydride
Days after adding catalyst
Methanesulfonic acid catalyst
Acetate in acetic acid - acetic anhyride
Propionate in propionic acid - propionic anhydride
Butyrate in butyric acid - butyric anhydride
% [η] of Regenerated cellulose in iron-sodium tartrate
Days after adding catalyst

Fig. 9. Viscosity reduction of cellulose esters in corresponding 50% acid–50% anhydride mixture at equivalent esterification rates

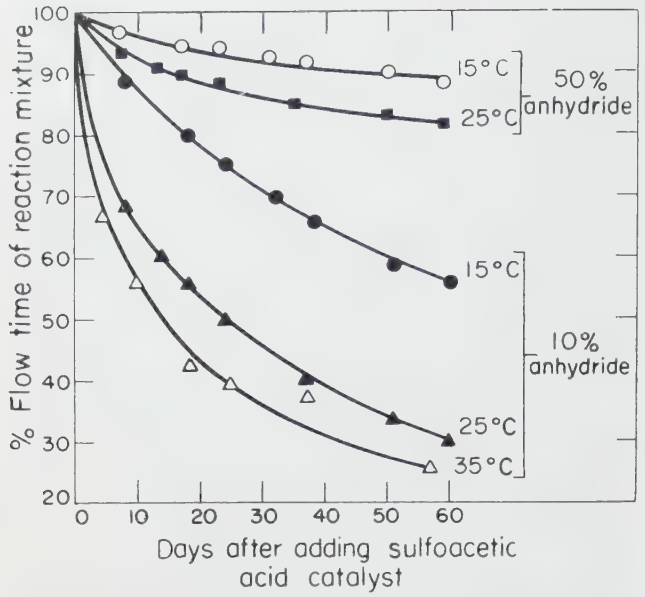


Fig. 10. Effect of temperature and acetic acid–acetic anhydride composition on viscosity reduction at equivalent esterification rates

which in turn is slower than the propionate in propionic acid–propionic anhydride. In 50% acid–50% anhydride (Fig. 9) the acetate in acetic acid–acetic anhydride also loses viscosity slowest, but there is little difference between the viscosity reduction in the other two systems.

In all cases the concentrations of sulfoacetic acid were lower than those for methanesulfonic acid required for equivalent esterification rates (Table II),

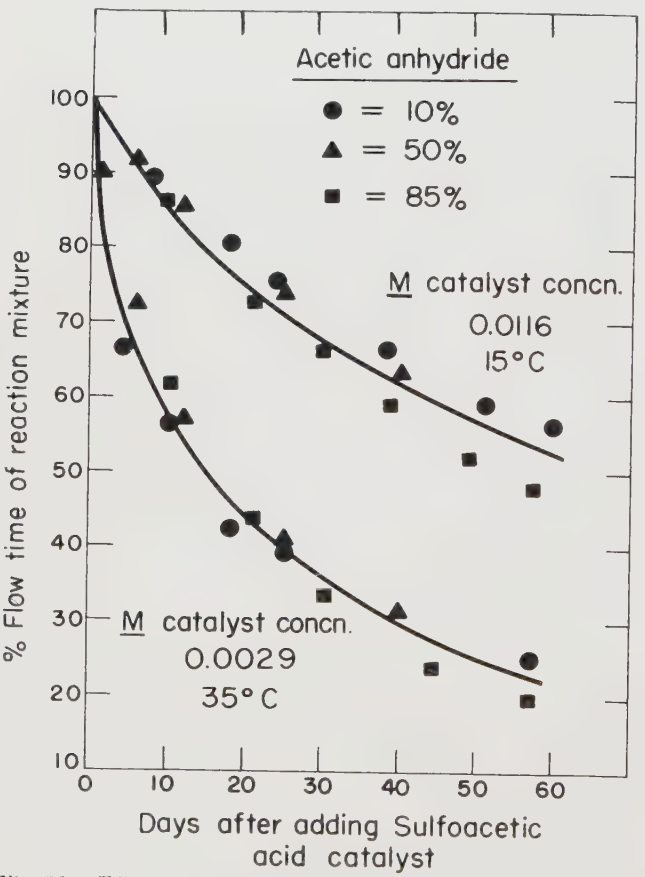


Fig. 11. Effect of acetic acid–acetic anhydride composition on viscosity reduction. Equimolal concentrations of sulfoacetic acid catalyst

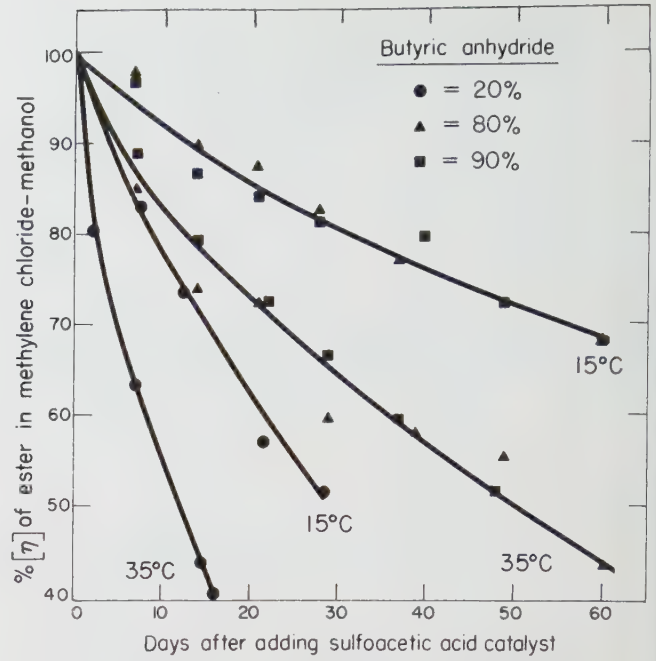


Fig. 12. Effect of temperature and butyric acid–butyric anhydride composition on viscosity reduction at equivalent esterification rates

showing that sulfoacetic acid has higher catalytic activity for esterification. At equivalent esterification rates degradation was usually faster with sulfoacetic acid (Figs. 8 and 9), showing that this catalyst is also more active in causing viscosity reduction.

For both catalysts the relative concentrations for equivalent esterification rates with different anhydrides depend on the amount of anhydride (Table II). With 10% anhydride in the presence of the corresponding acid *lower* concentrations of both catalysts were required with butyric anhydride than with propionic anhydride. A similar observation was made by Malm *et al.* (*4*)—faster esterification with butyric anhydride than with propionic anhydride at the same catalyst concentration. With 50% anhydride in the presence

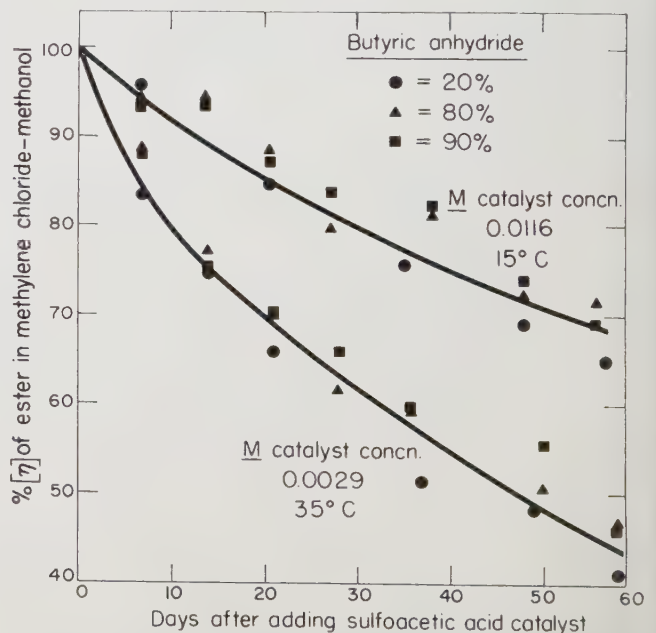


Fig. 13. Effect of butyric acid–butyric anhydride composition on viscosity reduction. Equimolal concentrations of sulfoacetic acid catalyst

Table III. Concentrations of Sulfoacetic Acid Catalyst Required for Equivalent Esterification Rates[a]

Esterification mixture,	*Anhydride, weight %*	*Catalyst concentration, M — 15°C.*	*25°C.*	*35°C.*
Acetic[b]	10	0.0116	0.0058	0.0029
	50	0.00174	0.00087	...
Butyric[c]	20	0.04	0.02	0.01
	80	0.0116	0.0058	0.0029
	90	0.0116	0.0058	0.0029

[a] Viscosity reduction is shown in Figs. 10 and 12. The original cellulose acetate butyrate contained 0.54 OH/g.u. Esterification rates were different for each of the two groups: *b* and *c*.
[b] 0.27 OH/g.u. after 30 min.; 0.20 after 60 min.
[c] 0.14 OH/g.u. after 30 min.; 0.11 after 60 min.

of the corresponding acid *higher* catalyst concentrations were required with butyric anhydride than with propionic anhydride (Table II).

This implies an interaction among esterification rate, amount of anhydride, and the type of anhydride. An interaction among viscosity reduction, amount of anhydride, and type of catalyst will be described in (section F).

E. Effect of Temperature, Catalyst Concentration, and Acid–Anhydride Ratio

The rate of viscosity reduction might also be influenced by the temperature, the nature and amount of catalyst, and the acid-to-anhydride ratio. Experiments were carried out to determine the contributions of these factors.

In this series of experiments sulfoacetic acid was chosen as the catalyst. Some of the foregoing experiments were done with perchloric acid catalyst; but it is so powerful that, especially at high temperatures and high anhydride concentrations, very small and unpractical concentrations would have been needed to be able to measure the esterification rates.

The ester was the same cellulose acetate butyrate referred to in section D. Its intrinsic viscosity in methylene chloride–methanol was 1.47 dl./g. When the free hydroxyls of this ester were completely acetylated without any appreciable chain cleavage, the intrinsic viscosity was 1.32 dl./g. Similarly, when the hydroxyls were completely butyrylated, the intrinsic viscosity was 1.26 dl./g. These values were used to calculate the viscosity changes in the appropriate acid–anhydride mixture.

Reactions were studied at 15, 25, and 35°C. in mixtures of acetic acid–acetic anhydride containing 10, 50, and 85% acetic anhydride by weight (Figs. 10, 11), and in butyric acid–butyric anhydride with 20, 80, and 90% anhydride by weight (Figs. 12, 13).

Viscosity Reduction at Equivalent Esterification Rates. In two groups of experiments (Table III) sulfoacetic acid concentrations were chosen so that the esterification rates were equivalent within each group at all temperatures and acid–anhydride compositions. These concentrations were found experimentally by checking the total hydroxyl content of the ester at four time intervals after adding catalyst; some of these values are shown in Table III.

Under these conditions some definite differences can be seen in the rates of viscosity reduction (Figs. 10, 12). Less viscosity reduction is favored by higher concentrations of anhydride at each temperature and by lower temperature with each acid–anhydride mixture.

In the case of acetic acid-acetic anhydride the viscosity falls faster in 90% acid–10% anhydride than in 50% acid–50% anhydride (Fig. 10; Table III, group *B*).

When the solvent was butyric acid–butyric anhydride (Fig. 12; Table III, group *c*), there was no significant difference between the mixtures containing 80 and 90% anhydride, but the viscosity reduction was much slower in these mixtures than in 80% butyric acid–20% butyric anhydride.

However, the catalyst concentrations for equivalent esterification rates varied with the acid-to-anhydride ratios. Therefore it is not possible to decide from these experiments alone whether the differences are due to the composition of the acid–anhydride mixtures or to the different catalyst concentrations.

This point was examined in experiments with equimolal catalyst concentrations. In acetic acid–acetic anhydride (Fig. 11) or in butyric acid–butyric anhydride (Fig. 13) viscosity reduction is essentially the same at all the acid-to-anhydride ratios studied, when the concentration of sulfoacetic acid and temperature are kept constant. Therefore the slower viscosity reduction at the higher anhydride concentration is due to the lower catalyst concentration used for equivalent esterification rates. However, the lower catalyst concentration which can be used when the temperature is increased (Figs. 10–13; Table III) is not sufficient to counteract the detrimental effect of the higher temperature.

F. Interaction Between Catalyst and Amount of Anhydride

The above holds true for sulfoacetic acid catalyst. However, when viscosity reduction of a cellulose ester was studied in a variety of solvent–acetic anhydride mixtures, using perchloric, methanesulfonic, and sulfoacetic acid catalyst, it was shown that with a change n solvent the order of rates of viscosity reduction varied with the three catalysts (*3*). In the present work with a tributyrate a similar effect is seen in acetic acid–acetic anhydride (Fig. 14) and in butyric acid–butyric anhydride (Fig. 15). With sulfoacetic acid catalyst the acid-to-anhydride ratio has little or no effect on viscosity reduction (Figs. 11, 13, 14A and 15A). However, with methanesulfonic acid (Figs. 14B and 15B) and perchloric acid (Figs. 14C and 15C), the solvent composition has a large effect on viscosity changes. Also, with the latter two catalysts the order is completely reversed in going from the anhydride, through acid–anhydride mixtures, to the acid.

Thus at equimolal catalyst concentrations generalizations can hardly be made about the effect of acid-to-anhydride ratios on viscosity changes, because the particular catalyst is another important factor interacting to affect viscosity changes in cellulose esters.

G. Effect of Amount of Butyric Acid on Viscosity Reduction in Butyric Acid–Butyric Anhydride

At concentrations of sulfoacetic acid required to produce equivalent esterification rates, viscosity reduction takes place more slowly as the amount of butyric acid is decreased (Fig. 16).

In these experiments 50 g. of the cellulose acetate

butyrate and 200 g. of butyric anhydride were mixed with 300, 550, and 800 g. of butyric acid; this provided 6, 11, and 16 parts of butyric acid, respectively. Viscosity reduction was studied at catalyst concentrations required to give equivalent esterification rates—the percentage of total hydroxyl of the ester decreased from 3.12 to 0.64 in 35 min., to 0.51 in 63 min., and to 0.38 in 120 min. With 11 and 16 parts of butyric acid, 0.02*M* sulfoacetic acid gave the same rates; 0.018*M* catalyst was required for the same rate with 6 parts of butyric acid.

The ester-to-anhydride ratio was the same in all experiments; the acid–anhydride compositions differ, but in the case of sulfoacetic acid catalyst this factor does not seriously influence viscosity reduction (Figs. 14A and 15A). Therefore the operating variables are the butyric acid-to-ester ratio and the catalyst concentration. Under these particular conditions slower viscosity reduction is favored by decreasing the butyric acid-to-ester ratio, which at the same time increases the effective anhydride concentration; at least in the case where the amount of butyric acid is lowest a smaller catalyst concentration can be used for equivalent esterification rates.

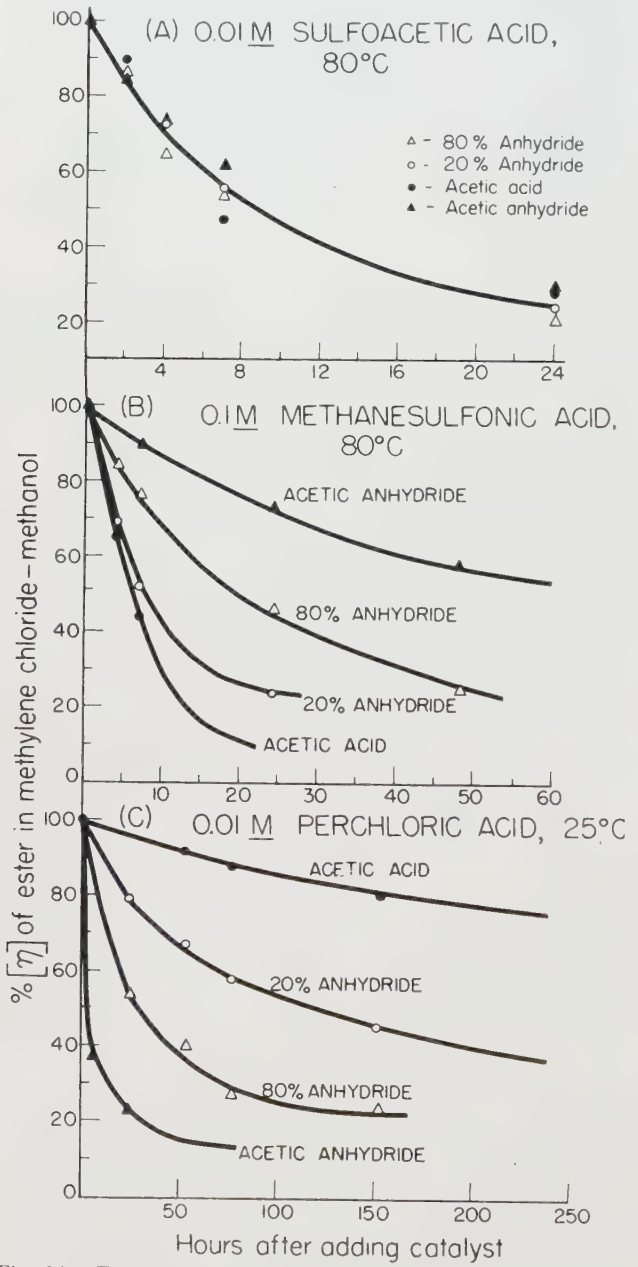


Fig. 14. Effect of acetic acid–acetic anhydride composition and nature of catalyst on viscosity reduction

DISCUSSION

In the manufacture of cellulose acetate, propionate, and butyrate, cellulose is made to react with the appropriate acid–anhydride mixture and catalyst, to introduce acyl groups. During this reaction it is usually desirable to prevent viscosity reduction as much

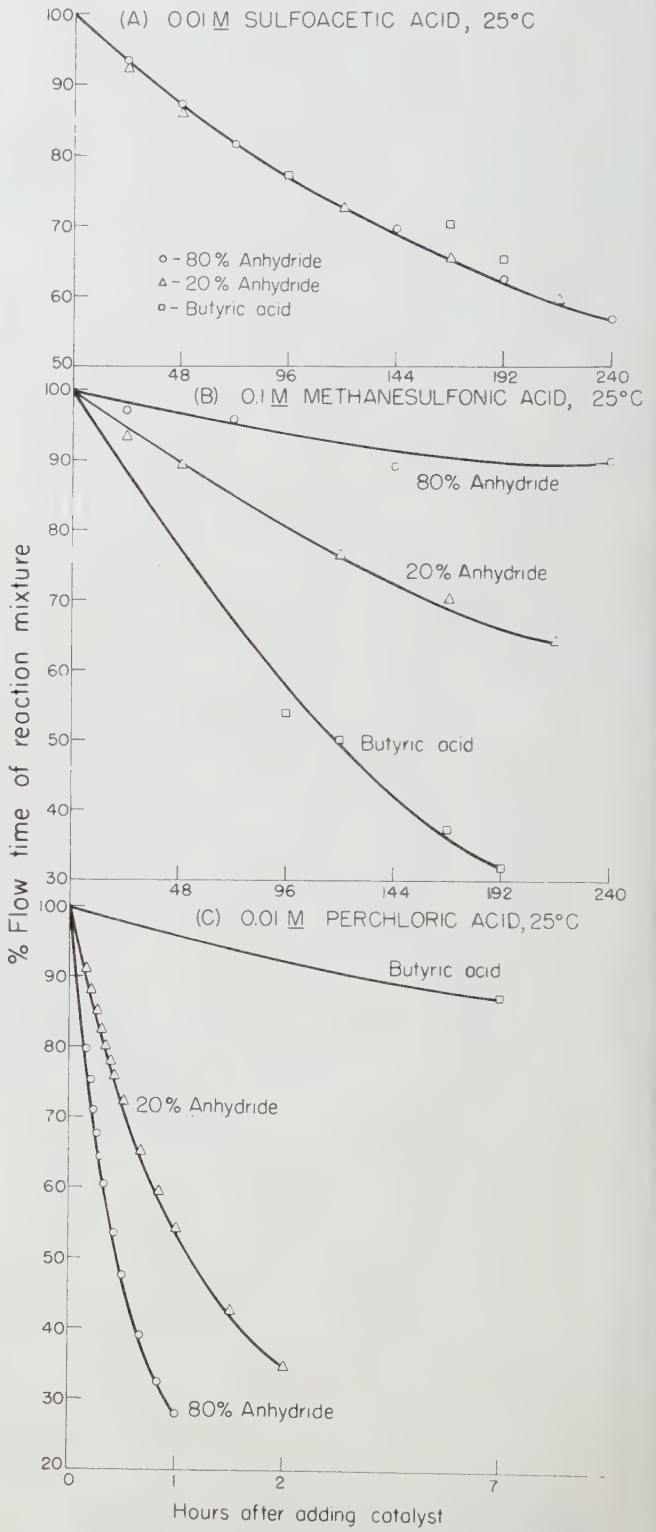


Fig. 15. Effect of butyric acid–butyric anhydride composition and nature of catalyst on viscosity reduction

Table IV. Effects of Various Factors on Viscosity Reduction

	Acyl group	Viscosity reduction[a] Ac	Pr	Bu	Fig.
I. Effect of Acyl Group in Ester and in Solvent Consisting of 90% Acid–10% Anhydride Mixture					
Catalyst, equimolal concn.					
Perchloric, sulfoacetic, and methanesulfonic acids	In ester (same solvent)	1	2	3	1–3
Perchloric, sulfoacetic and methanesulfonic acids	In acid–anhydride mixt. (same ester)	3	2	1	4, 5
Perchloric acid	Same in ester and acid–anhydride mixt.	3	2	1	6
Sulfoacetic and methanesulfonic acids	Same in ester and acid–anhydride mixt.	1	2	3	7
Catalyst, concn. for equivalent esterification rates					
Sulfoacetic and methanesulfonic acids	Same in ester and acid–anhydride mixt.	3	1	2	8
II. Effect of Acid-Anhydride Ratio					
	Effect				
Catalyst, equimolal concn.					
Sulfoacetic acid	None				11, 13–15
Methanesulfonic acid	More anhydride—slower viscosity reduction				14, 15
Perchloric acid	More anhydride—faster viscosity reduction				14, 15
Catalyst, concn. for equivalent esterification rates					
Sulfoacetic and methanesulfonic acids	More anhydride—slower viscosity reduction				8–10, 12
III. Effects with Sulfoacetic Acid Catalyst at Equivalent Esterification Rates					
Faster viscosity reduction caused by					
i. Higher temperature					10, 12
ii. Higher butyric acid to ester ratio					16

[a] 1 is fastest, 2 is intermediate, 3 is slowest viscosity reduction.

as possible. The present work shows opposing factors which affect the viscosity, and these are summarized in Table IV.

The acyl group in the cellulose ester exerts an influence, so that cellulose acetate loses viscosity faster than the propionate and butyrate in the same solvent (Figs. 1–3). On the other hand, the particular acid–anhydride mixture also has an effect, so that the same ester loses viscosity faster in butyric acid–butyric anhydride than in propionic acid–propionic anhydride or acetic acid–acetic anhydride (Figs. 4 and 5).

The present work also shows that in mixtures of acetic acid–acetic anhydride and butyric acid–butyric anhydride, lower temperatures favor less viscosity reduction (Figs. 10–13). But at lower temperatures esterification is slower for the same amount of catalyst. The rate of esterification can be increased by increasing the anhydride and/or catalyst concentration.

It seems that if these were the only factors involved, then the manufacture of cellulose esters would be simplified by choosing lower temperatures and higher anhydride concentrations, and balancing these against the correct catalyst concentration. However, in the case of cellulose acetate a relatively large liquid-to-solid ratio is needed in commercial practice because of the limited solubility of the fully esterified product in the esterification mixture. The solubility could be improved by using higher temperatures, but this would be at the expense of larger losses in viscosity. Increasing the anhydride concentration is expensive. Commercially, it has been found feasible to keep the anhydride concentration at relatively low levels because for the same rates of esterification, cellulose acetates break down more slowly than other esters in their corresponding acid–anhydride mixtures (Figs. 8 & 9).

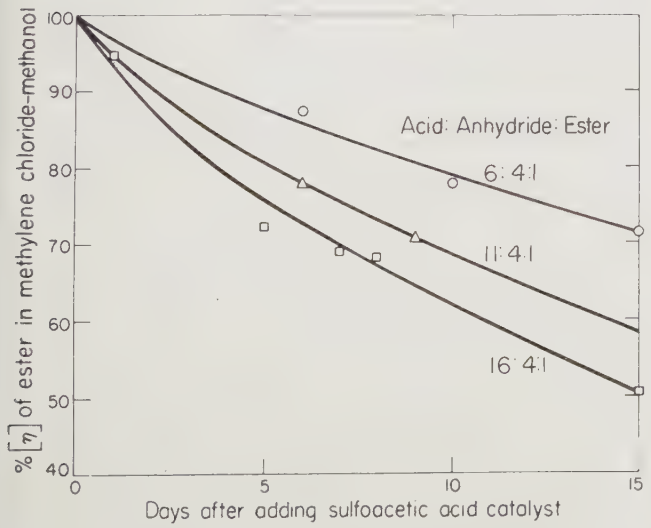


Fig. 16. Effect of butyric acid to ester ratio at constant butyric anhydride to ester ratio on viscosity reduction at equivalent esterification rates

In the manufacture of cellulose butyrate it is feasible to use a low liquid-to-solid ratio because of the good solubility of cellulose tributyrate in butyric acid–butyric anhydride. The butyric anhydride concentration can therefore be increased by decreasing the amount of butyric acid (*1*) but using the same amount of anhydride (Fig. 16). Preserving the viscosity is a more serious problem than in the manufacture of cellulose acetate, because experience shows that, for the same rates of esterification, cellulose butyrate in butyric acid–butyric anhydride loses viscosity faster than cellulose acetate in acetic acid–acetic anhydride (Figs. 8 and 9). However by choosing lower temperature (Fig. 12) and higher butyric anhydride concentration (Figs. 12 and 16), less viscosity reduction occurs at equivalent esterification rates.

In any acid–anhydride mixture lower catalyst concentrations favor less viscosity reduction. Therefore a combination of low catalyst and correspondingly high anhydride concentration favors less viscosity reduction and at the same time makes it possible to achieve satisfactory esterification rates. On the other hand, the relative amounts of viscosity reduction taking place in two mixtures of different acid-to-anhydride ratio vary with the catalyst (Figs. 14 and 15).

Faster esterification occurs at higher anhydride concentration for the same temperature and catalyst concentration. Therefore even when more viscosity reduction occurs at higher anhydride concentration at

a given concentration of certain catalysts (e.g., perchloric acid, Figs. 14 and 15), the higher anhydride concentration permits the use of less catalyst, and this minimizes viscosity reduction.

In conclusion, viscosity reduction is influenced by temperature, the acyl group in the ester and in the acid–anhydride mixture, the concentration and type of catalyst, the anhydride concentration, and the acid-to-ester ratio. At catalyst concentrations chosen to promote equivalent esterification rates in acid–anhydride mixtures of different composition and at different temperatures, less viscosity reduction occurs at higher anhydride concentration and lower temperature. The proper balance of all these factors is essential for the successful manufacture of cellulose esters.

SUMMARY

The conditions which influence the viscosity reduction of cellulose in its esterification with lower aliphatic anhydrides were determined from viscosity changes of cellulose acetates, propionates and butyrates in different acid–anhydride systems.

It was found that viscosity reduction depended on the acyl group in the ester and in the acid–anhydride system, the anhydride concentration, the nature and concentration of the catalyst, and the temperature of the reaction.

LITERATURE CITED

1. Blanchard, L. W., Jr., U. S. pat. 2,208,569 (July 23, 1940).
2. Malm, C. J., Nadeau, G. F., and Genung, L. B., *Ind. Eng. Chem., Anal. Ed.* 14: 292 (1942).
3. Malm, C. J., Tanghe, L. J., and Glegg, R. E., *Ind. Eng. Chem.* 51: 1483 (1959).
4. Malm, C. J., Tanghe, L. J., Herzog, H. M., and Stewart, M. H., *Ind. Eng. Chem.* 50: 1061 (1958).
5. Malm, C. J., Tanghe, L. J., Laird, B. C., and Smith, G. D., *Anal. Chem.*, 26: 188 (1954).
6. Valtasaari, L., *Paper and Timber* No. 4: 243 (1957).

Received March 29, 1961. Presented before the Cellulose Division at the 139th Annual Meeting of the American Chemical Society, held in St. Louis, Mo., March 21–30, 1961.

The authors gratefully acknowledge the experimental work of W. N. Poillon, A. M. Lewis, R. B. DeMallie, and J. A. Haefner.

Sequential Startup Procedure for Pulp Drying Machine

J. GLENN OLREE

The use of the sequential testing procedure for basis weight control on startups of the pulp-drying machine is explained. The problem is approached from two points of view: theoretically, and actual plant experience. Such topics as the applicability of the procedure to the basis weight startup problem, sensitivity to shifts in level, the number of tests necessary to reach a decision when using one-sided and two-sided limits, the efficiency of the method, methods of recording data, the use of a target range instead of a precise target value, plant experiences with the charts, and advantages to be derived from the use of the charts are discussed. A mathematical Appendix containing the formulas and explanations of the calculations needed to set up the procedure is included, along with explanatory tables and graphs. It is concluded that such a procedure is applicable, not only to the basis weight variable, but to the startup of any process which can be sampled and measured rapidly and for which adjustments can be made, and that such a procedure works very satisfactorily in actual practice in the plant.

Most people who have been exposed to statistical procedures have heard about, if not actually used, the Wald sequential test of significance (*1*), the Barnard sequential "*t*" test (*2*) or some similar sequential test procedure. As a general rule, the applications and examples of these procedures given in the literature appear to be limited to such concepts as the comparison of two means, the comparison of a mean with a standard value, the comparison of two methods or processes, etc., which, even though they are excellent presentations and excellent examples, are nevertheless slanted toward laboratory experimentation or experimental design. Only recently has there been any effort to apply the sequential procedure to the field of quality control (*3–6*), and even these have stressed a different method of determining the limits to be used. The purpose of this article is to suggest and explain another use for this very versatile procedure; namely, to control the start up of a process at a desired level.

J. Glenn Olree, Staff Specialist, Quality Control Section, Operations Department, Cellulose and Specialties Technical Division, Buckeye Cellulose Corp., Memphis, Tenn.

REVIEW

The sequential procedure is primarily a tool for hypothesis testing, and it continues to hold that role here. Although there are several methods of recording data for comparison with the critical values, our discussion will be limited to the graphical procedure by use of cumulative totals, since it is felt that this method involves the least amount of on-the-spot calculation and is probably the easiest to use. However, a different method of recording may be needed for a particular situation.

The use of the one-sided sequential test is illustrated in Fig. 1. The chart is divided into three decision-making zones: (1) in which the Null Hypothesis is accepted; (2) in which the Alternative Hypothesis is accepted; and (3) in which the decision is to continue sampling. As each new observation is taken, the value of a function of all the observations recorded up to that time (which in our case is the coded cumulative sum) is plotted against the number of observations included in the value. A decision is made following each observation, and the indicated action is taken.

According to Davies (*7*), a suitable two-sided test may be obtained by superimposing two single-sided tests in each of which the error of the first kind is set at $^1/_2\alpha$ and δ is taken to be positive in one test and negative in the other. (For the calculation of the double-sided limits and the construction of the charts, see the Appendix.) If overlapping zones are disregarded, by including each in the zone with the most

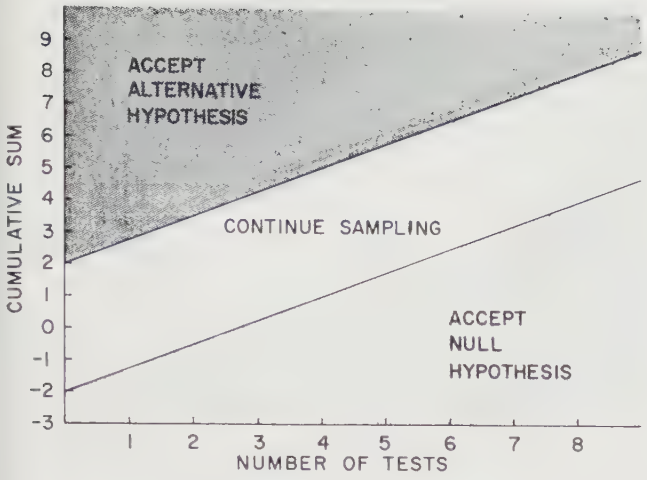


Fig. 1. One-sided sequential test

logical of the two conclusions, this results in the division of the chart into four zones as shown in Fig. 2

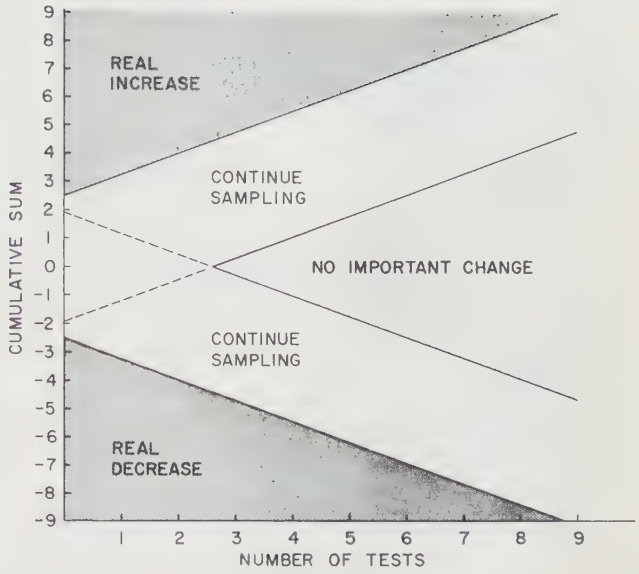


Fig. 2. Two-sided sequential test

APPLICATION TO PULP-DRYING MACHINE

Now let us consider the startup of a pulp-drying machine where a desired level of basis weight is specified. Let us assume that handling facilities will allow the material to be wrapped immediately for shipment, thereby eliminating the need for extra handling. Under the usual Shewhart control chart system (*8*), when one test result is obtained which is within the control limits, the material is assumed to be at the desired level (there is no indication to the contrary) and is wrapped for shipment. As additional results become available, however, it is determined that the machine was *not* levelled out at the desired basis weight. All the material thus far produced and wrapped (which may in some cases be a very sizable amount) must be rejected, pulled back out of the shipping department warehouse, and re-worked. In some cases, the product has been treated in some way so that it cannot be re-worked but must be discarded, which represents a complete loss. It would be much better from a cost standpoint, and often from a quality standpoint, if enough tests were performed on the product to be reasonably sure that it would meet specifications *before* wrapping it for shipment. This would allow the adjustment and levelling out of the machine before a great deal of off-quality material is produced. What more efficient way could be used to determine whether or not the material being produced on startup is at the desired basis weight level than that of sequential testing?

By simply re-labelling the four decision-making zones of the double-sided sequential chart as shown in Fig. 3, the application to control of basis weight on startup may be made. Before using this in the plant, however, it is necessary to determine several other things.

NUMBER OF TESTS NECESSARY

One thing which must be determined is whether or not the sequential procedure can be made sufficiently sensitive to process shifts in level, within a reasonable number of tests, to be of any use in the plant. In other words, if appropriate risks are chosen and a desired detectable difference is stated, will the number of tests needed to make a decision be prohibitive from a practical standpoint? Or, if appropriate risks are chosen and a practical number of tests is determined, will the difference detectable be larger than can be tolerated?

It should be emphasized here that, if the sequential procedure *cannot* be made sufficiently sensitive to process shifts in level within a reasonable number of tests, there is *no known* alternative for making this type of decision. Any other known procedure for determining whether the process is operating at the desired level requires more testing and, consequently, cannot be made as sensitive as the sequential procedure within the same number of tests.

Suppose it is decided that a true level of 1.5 units away from the desired level must be detected. This difference to be detected is hereafter referred to as delta (δ). Suppose further that the risks of the first (α) and second (β) kinds shall be set at $\alpha = \beta = 0.05$, $\sigma = 1.0$ units. How many tests will be required before deciding to accept or to reject the material?

In order to determine this, we must first assume a value for the true level. Common sense dictates that material produced closer to the desired level will be accepted sooner than material produced farther away from the desired level. On the other hand, material produced farther away from the desired level will be rejected sooner than that which is produced closer to the desired level. Our aim is to insure (within our confidence limits) that material produced at the desired level will be accepted, and that material produced 1.5 units away from the desired level will be rejected. The number of tests necessary to make a decision is dependent upon the true level of the process with respect to the desired level. Therefore, it stands to reason that the largest number of tests needed to make a decision would be expected when the true level is somewhere between the desired level and the desired level plus delta (the difference to be detected). As the true level approaches either of the two, the number of tests necessary to reach a decision becomes smaller.

After assuming the true level of operation, it is still impossible to determine how many tests will be

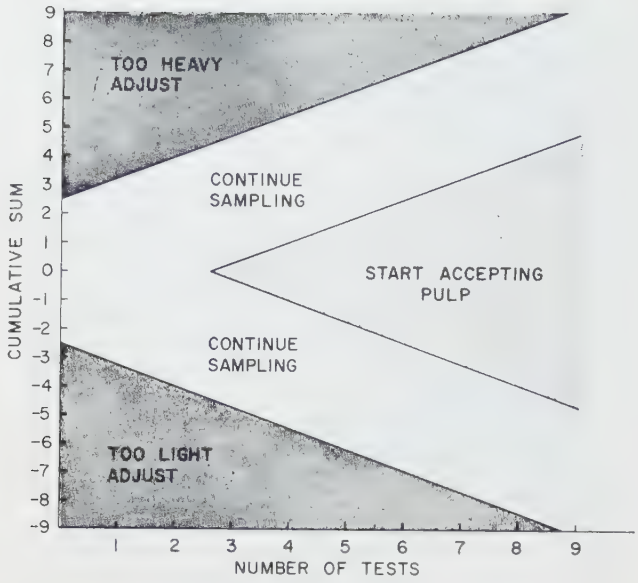


Fig. 3. Two-sided sequential test applied to basis weight

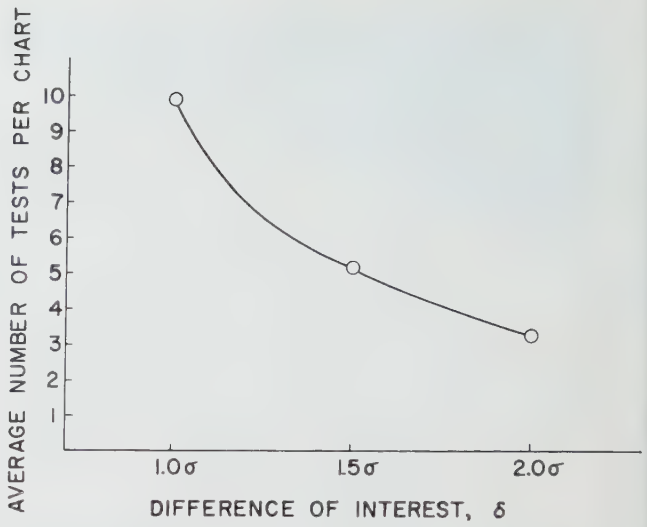


Fig. 4. Number of tests necessary when $\mu = \mu_0$, based on 100 charts from random deviates.

necessary at any particular time because the number varies from one time to the next by the very nature of the sequential procedure (i.e., there is no set number of tests to be performed). Therefore, any value obtained is only an average number of tests necessary to come to a decision when the true level is specified. These values, when using one-sided limits, may be computed (7) for the cases where the true level is equal to the desired level, the true level is equal to the desired level plus delta, and the true level is equal to the desired level plus one-half delta (see also Appendix).

However, no formulas were found for obtaining these values when using two-sided limits. Therefore, in order to determine the average number of tests necessary to make a decision when using two-sided limits, and considering that the true level is equal to the desired level, 100 charts were plotted from a table of random normal deviates for each of the following values of δ: $\delta = 1.0\sigma$, $\delta = 1.5\sigma$, and $\delta = 2.0\sigma$. The results are given in Table I and summarized graphically in Fig. 4. In our case where $\delta = 1.5\sigma$ and $\alpha = \beta = 0.05$, the average number of tests is about 5.2.

This compares with a set number of nine tests by a nonsequential procedure with the same difference detectable and the same risks. It is readily apparent, then, that the sequential procedure is much more efficient and that the number of tests required is not excessive in this case.

It is also of interest to determine the average number of tests needed when the true level is at some value other than the desired level. This was determined empirically for several levels by incorporating a constant bias into the table of random normal deviates. If μ_0 is the desired level, $\alpha = \beta = 0.05$, and $\delta = 1.5\sigma$, approximate values have been obtained for cases where the true value is equal to $\mu_0 + 0.5\sigma$, $\mu_0 + 0.75\sigma$, $\mu_0 + 1.0\sigma$, $\mu_0 + 1.5\sigma$, and $\mu_0 + 2.0\sigma$. The results of these plots are given in Table II and summarized graphically in Fig. 5. It can be seen that the average number of tests needed when $\mu = \mu_0 + \delta$ and $\mu = \mu_0 + S$ is 3.5 and 6.9, respectively. It has already been shown in Table I that the average number of tests is 5.2 when $\mu = \mu_0$. Approximate values may be obtained in a similar manner for any desired set of conditions.

As a point of interest, it might also be observed that the proportion of charts calling for adjustment under the various conditions of bias resulted in a curve which looks very familiar even to the person with only a casual acquaintance with statistics. The curve shown

Table I. Number of Tests Necessary when $\mu = \mu_0$
Based upon random deviates
$\alpha = \beta = 0.05$

N	$\delta = 1.0\sigma$		$\delta = 1.5\sigma$		$\delta = 2.0\sigma$	
	No. charts comp. at N	*Cumulative*	*No. charts comp. at N*	*Cumulative*	*No. charts comp. at N*	*Cumulative*
2	..	..	..	..	33	33
3	..	..	15	15	30	63
4	..	..	33	48	23	86
5	..	..	27	75	9	95
6	5	5	8	83	1	96
7	20	25	6	89	2	98
8	22	47	3	92	1	99
9	14	61	1	93	1	100
10	4	65	3	96	..	..
11	9	74	1	97	..	..
12	4	78	1	98	..	..
13	8	86	0	98	..	..
14	1	87	2[a]	..	..	..
15	4	91	..	..	..	..
Beyond	9	100	..	..	..	..
Av. per chart	9.9		5.2		3.3	

[a] Beyond 13.

Table II. Number of Tests Necessary When $\mu = \mu_0 + A$
Based upon random deviates[a]
$\alpha = \beta = 0.05$, $\delta = 1.5\sigma$

No. tests	A = 0.5σ		A = 0.75σ		A = 1.0σ		A = 1.5σ		A = 2.0σ	
	No. charts	Cum. Total	No. charts	Cum. Total	No. charts	Cum. Total	No. charts	Cum. Total	No. charts	Cum. Total
1		..	3	3	5	5	13	13	23	23
2	1	1	9	12	16	21	21	34	46	69
3	12	13	12	24	11	32	30	64	22	91
4	26	39	15	39	14	46	15	79	6	97
5	12	51	8	47	14	60	8	87	1	98
6	8	59	8	55	6	66	4	91	2	100
7	10	69	10	65	10	76	1	92	..	..
8	5	74	9	74	7	83	5	97	..	..
9	5	79	2	76	3	86	1	98	..	..
10	5	84	8	84	0	86	2	100	..	..
11	4	88	2	86	3	89	..	..	..	..
12	3	91	0	86	2	91	..	..	..	..
13	1	92	3	89	4	95	..	..	..	..
14	0	92	3	92	2	97	..	..	..	..
15	0	92	2	94	1	98	..	..	..	..
Beyond	8	100	6	100	2	100	..	..	..	..
Av. no. tests per chart	7.4		6.9		5.8		3.5		2.2	
	Out	In	Out	In	Out	In	Out	In	Out	In
Totals	20	80	49	51	77	23	99	1	99	1

[a] These are empirical data, determined experimentally, and should not be taken as exact, theoretical data.

in Fig. 6, is given only as an indication of the type of response observed, and not as a comparison of the actual to the theoretical curve.

PRACTICAL CONSIDERATIONS

Once the number of tests needed is determined, a method of recording the data must be decided upon. To make the best use of the procedure, the data must be recorded in a simple and easily understood manner. The possibilities to be explored might include some modification of the following:

1. Use cumulative averages and compare to limits recorded in table form.
2. Use cumulative averages and plot graphically with appropriate limits on the graph.
3. Use cumulative totals and compare to limits recorded in table form.
4. Use cumulative totals and plot graphically with appropriate limits on the graph.

It is felt that no. 4 above involves the least amount of calculation by plant personnel, and will probably be the easiest to use.

It is also essential to determine whether plant production data actually follow the theoretical calculations. This may be done in an approximate manner by plotting data from the past production records. Or, if a more scientific method is desired, several experimental runs may be made by using the sequential charts.

Other factors which must be considered before deciding to use this procedure in the plant would include physical limitations and whether they will allow samples to be taken rapidly.

Some processes may not allow the taking of samples closer together than some specified time. For example, production of pulp or paper does not allow sampling in the middle of a reel (with the possible exception of tear-out samples, or special sampling devices under certain conditions). Since all samples must be obtained at reel breaks, and since the taking of only one set of samples at each reel break would defeat the purpose of the sequential procedure (which is to decide *before wrapping* whether or not the material is acceptable), the question arises as to whether samples taken at the tail of a reel are *representative* of the average level throughout the reel and whether the samples are independent if they are all taken from the same reel. The first part of this question, evidently, has already been answered in the affirmative by all companies using the standard Shewhart control charts, even though this may be open to question if the machine

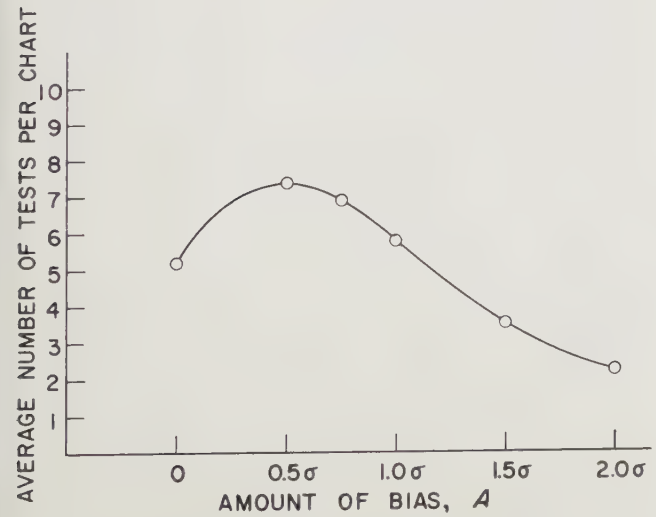


Fig. 5. Number of tests necessary when $\mu = \mu_0 + A$, based on 100 charts from random deviates, $\delta = 1.5\sigma$

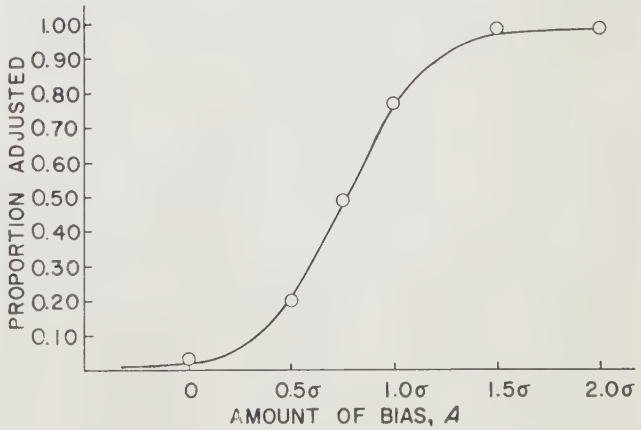


Fig. 6. Proportion of charts calling for adjustment when $\mu = \mu_0 + A$, based on 100 charts from random deviates, $\delta = 1.5\sigma$

Table III. Worksheet for Startup Chart

Target = 100

Front	*Center*	*Back*	*Average*	*Average minus target*	*Cumulative total*
99.7	99.6	100.7	100.0	0	0
101.0	100.4	102.1	101.2	+1.2	+1.2
100.9	102.2	99.2	100.8	+0.8	+2.0
97.2	101.2	100.6	99.7	−0.3	+1.7
100.0	100.2	102.3	100.8	+0.8	+2.5
99.0	98.0	99.1	98.7	−1.3	+1.2

exhibits pronounced long term cyclic or trend effects.

As to the independence of the observations, several tests for nonrandomness are available, among which are the mean square successive differences test (*8*), circular or autocorrelation (*9*), runs or sign test (*8*), and test of the number of maxima (*10*). It is sufficient to determine that the observations are independent only over the period of time covered by the sampling if the assumption of representativeness is correct.

Even though no mention has been made of it as yet, it is assumed that the method of testing is rapid enough to allow the running of several tests within the length of time necessary to produce a reel of pulp and that the test results are available in sequence.

CONTROL OF AVERAGE BASIS WEIGHT ON STARTUP

Having examined the foregoing conditions and found they have been met to a reasonable degree, and having prepared the sequential startup charts with the appropriate limits, as explained in the Appendix, we are ready to apply this procedure to the startup of a pulp-drying machine. The parameter of interest is average basis weight.

When machine running speed is reached and the machine has settled at a particular level of basis weight, a new reel is started. Samples may then be taken from the previous reel by cutting down into the reel, making sure that no sample from material produced prior to the last machine adjustment is taken. Sets of samples representing the front, center, and back of the machine are cut to exact dimensions, dried in an infrared oven, and weighed immediately on a grain balance. The balance reading is converted into basis weight in pounds (500-sheet ream). The average basis weight of each set of three samples is calculated, and the desired average, or target value, is subtracted from each. The cumulative sums of these coded values are plotted on the sequential chart opposite the number of observations, and the indicated action is taken as each new observation is plotted.

For example, suppose that the target value is 100 lb., $\sigma = 1.0$, $\delta = 1.5\sigma$, $\alpha = \beta = 0.05$. (σ here refers to the standard deviation of the average of three tests, not the individual results.) A typical worksheet, when the true level is equal to the desired level, is shown in Table III, and the completed startup chart is shown in Fig. 7. This is evidence that the material being produced is acceptable (as far as the average basis weight is concerned), and the material being wound on the reel while the tests were being made may be accepted and wrapped for shipment.

If one plotted point falls in the "adjust" zone (either too heavy or too light), the material is not acceptable, a machine adjustment is made, all points

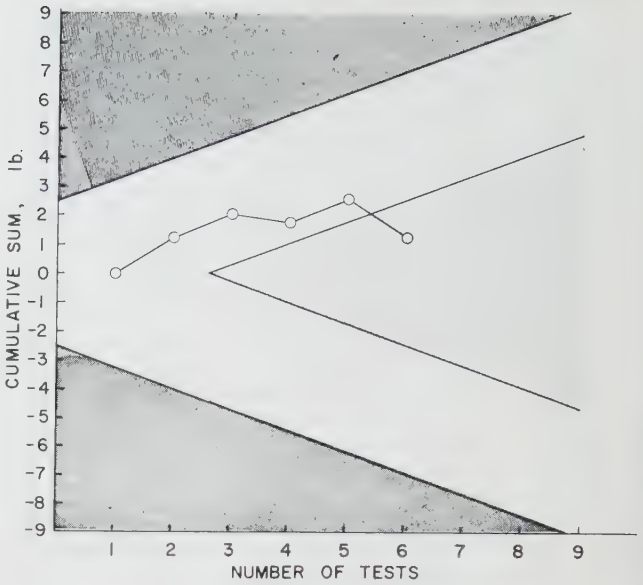


Fig. 7. Typical startup chart

previously plotted are disregarded, new samples are taken after the adjustment, and the procedure is repeated. This continues until acceptable material is produced, as evidenced by the startup charts.

Following the startup, the quality is controlled by use of the regular Shewhart control charts. If at any time during the production run a plotted point falls outside the acceptance limits on the control chart, the material is rejected and the startup procedure initiated again until the proper level is reached. It should be stressed also that any grade change, change in type, or change in basis weight, which requires an adjustment of *any kind* on the *wet end* of the machine, requires a new startup. If adjustments are made for any reason during the sampling and testing while starting up, all data previously plotted are made void. Regular adjustments made while controlling by the regular control charts do not require a new startup unless the plot falls outside the acceptance limits.

TARGET RANGE

Sometimes in other fields, as well as in the case of the pulp-drying machine, a precise target is neither necessary nor desirable. Circumstances may permit the acceptance of material with a basis weight of 99 or 101 lb. and consider this material just as good in quality as that produced at a level of 100 lb. How can this situation be handled with the sequential startup procedure? The usual and immediate answer is "simply increase delta (the difference of interest)." It appears, however, that this is not the complete answer. While it is true that this procedure will continue to insure the rejection of material which is produced at a true level of $\mu_0 + \delta$ (μ_0 being the middle of the desired level), it will *not* insure the *acceptance* of material produced at a true level of $\mu_0 + R/2$ or $\mu_0 - R/2$ (R being the range of acceptable values).

Therefore, it is suggested that the charts be designed with a target *range*, instead of a *precise* target value. This not only changes the intercept points of the limits with the zero observation axis (the points now being counted from the top of the range for the top limit and the bottom of the range for the bottom limit, etc.), but it also increases the slope of the limits by an

Table IV. Number of Tests Necessary
Based upon plant experience

Target value of ± 1 lb.			Precise target value		
N	No. charts comp. at N	Cumulative	N	No. charts comp. at N	Cumulative
1	14	14	1	1	1
2	13	27	2	0	1
3	6	33	3	10	11
4	3	36	4	17	28
5	0	36	5	7	35
6	2	38	6	5	40
7	1	39	7	1	41
8	1	40	8	1	42
Av. per chart 2.4			Av. per chart 4.3		

amount equal to $R/4$. For example, if the target is changed from a precise target value of 100 lb. to a target range of 99 to 101 lb., the upper and lower limits on the top side would be counted from 101 lb., the upper and lower limits on the bottom side would be counted from 99 lb., and the slope of the limits is increased by 0.5. In this way both the α and β risks remain the same as for the precise target value.

PLANT EXPERIENCE

The procedures outlined in this article have been in use at our Memphis plant for almost three years, with very satisfactory results. By taking 42 charts representative of the precise target value, and 40 charts representative of the target range, it has been determined that the average number of tests necessary to complete a chart is 4.3 for the precise target and 2.4 for the target range. (See Table IV).

We have also used these procedures very successfully for control of the across-the-sheet profile of basis weight on startups. Sequential charts are prepared for the particular cross-machine-direction parameter being calculated, and plots are made to determine whether or not the parameter is at the desired level. A discussion of the particular parameters involved is beyond the scope of this article.

Several problems were encountered in the application of the charts in the plant. Control charts with horizontal limits were in common use, but no charts with inclined limits had ever been used in the plant. Inexperience with the inclined limits caused adjustments to be made too soon. The charts were wrongly interpreted to mean that the machine was gradually drifting away from the desired average. It was explained that the picture obtained is a *normal* one for this type of chart.

Another problem was encountered in the method of rapid sampling. Plant personnel insisted that this would not be a representative sample because of production "trends" along the machine. Extensive experiments were made and data were analyzed from several production periods without obtaining any evidence for the existence of trends within the production period covered by the startup procedure. It was determined that samples could be taken as close together as desired (even adjacent to one another in the machine direction), without any evidence of nonindependence.

The idea was also expressed that the decision by this procedure was made on the basis of only one test, since the instructions were to continue testing until one point falls inside the limits, then start accepting the pulp. It was necessary to explain that each plotted point includes the data from previous tests, since the plotted points are cumulative totals.

Since these problems and others have been explained and solved, the use of the sequential startup charts in the plant has proceeded very satisfactorily.

ADVANTAGES

Several benefits have been derived from the use of this procedure. It allows a decision to be reached sooner and with more assurance than had previously been possible. In addition to a reduced amount of rework material being produced on startups and a better assurance that the material being produced will meet specifications, better basis weight control can now be achieved because of the generated necessity for making smaller machine adjustments than had been previously practiced. This has also given opportunity for more discussions of basic statistical techniques with plant personnel, since it has created more interest on their part.

CONCLUSIONS

The following conclusions may be reached on the basis of our experience:

1. The sequential testing procedure is applicable to the startup of the pulp-drying machine in determining whether or not the basis weight is at the desired average level.
2. The method has proved rapid enough to allow the making of a decision well before a roll is ready to be wrapped. The time required varies, but usually averages about 15 min. after the beginning of a new reel.
3. The method is sufficiently sensitive to reasonable departures from a desired level for machine control on startups.
4. The sequential procedure is much more efficient than a nonsequential procedure.
5. The insertion of a target *range* rather than a *precise* target value is possible and practicable.
6. Actual plant experience bears out theoretical values and predictions from the sequential startup procedures.
7. Closer basis weight control is now possible, largely due to the use of the startup charts.
8. The sequential procedure can probably be adapted to the startup of any process which can be sampled and measured rapidly and for which adjustments can be made.

APPENDIX

The calculations involved in setting up sequential startup charts using two-sided limits are given below.

The quantities needed are:

μ_0 = the target value
δ = $\mu - \mu_0$, the difference which must be detected.
α = the risk of asserting a difference when none exists.
β = the risk of asserting no difference when a difference of δ exists.
σ = the standard deviation of the observations.

The procedure is as follows:

1. Calculate:

$$h_0 = -b\sigma^2/\delta$$
$$h_1 = a\sigma^2/\delta$$

$$h_2 = -b\sigma^2/-\delta$$
$$h_3 = a\sigma^2/-\delta$$
$$S = (\mu_0 + \mu_1)/2$$

where

$a = \ln (1 - \beta)/\alpha/2$, and
$b = \ln (1 - \alpha/2)/\beta$

These values may be found in tables such as those given in Davies, p. 616 (*7*). If desired, μ_0 may be set equal to zero by subtracting the target value from each observation. Then S becomes equal to $\delta/2$.

2. Draw the limits on the chart using the following values which were determined in 1.

h_1 = the intercept point of the upper, positively sloped limit with the zero observation axis.
h_0 = the intercept point of the lower, positively sloped limit with the zero observation axis.
h_2 = the intercept point of the upper, negatively sloped limit with the zero observation axis.
h_3 = the intercept point of the lower, negatively sloped limit with the zero observation axis.
S = the slope of the limits (use as both positive and negative for two-sided limits).

The limits are then:

$h_0 + nS$ (S positive)
$h_1 + nS$ (S positive)
$h_2 + nS$ (S negative)
$h_3 + nS$ (S negative)

3. Determine the approximate average number of tests required. For the two-sided test, no formulas are known, but the average number of tests when $\mu = \mu_0$, $\mu = \mu_1$, and $\mu = S$ may be determined for any set of conditions by plotting from a table of random normal deviates. In the case where $\alpha = \beta = 0.05$ and $\delta = 1.5\sigma$, the values are approximately as follows:

$\bar{n}_0 = 5.2$
$\bar{n}_1 = 3.5$
$\bar{n}_s = 6.9$

For the one-sided test, these values may be calculated from the following formulas:

$$\bar{n}_0 = \frac{(1 - \alpha)h_0 + \alpha h_1}{\mu_0 - S}$$

$$\bar{n}_1 = \frac{\beta h_0 + (1 - \beta)h_1}{\mu_1 - S}$$

$$\bar{n}_s = \frac{-h_0 h_1}{\sigma^2}$$

If the average number of tests is too large, modify the scheme.

4. Take observations and plot the cumulative total of the observations against the number of observations on the chart. The indicated decision is made as each point is plotted.

If a target *range* is desired rather than a *precise* target value, the same calculations are made, with the following changes:

1. h_0 and h_1 are now counted from the top of the range.
2. h_2 and h_3 are now counted from the bottom of the range.
3. The formula for the positive slope (when $\mu_0 = 0$) now becomes

$$S = \delta/2 + R/4$$

where R is the target range. The negative slope is $-S$.

LITERATURE CITED

1. Wald, A., "Sequential Analysis," New York, John Wiley 1947.
2. Barnard, G. A., *J. Royal Statistical Soc. Suppl.* 8: pp. 1-ff. (1946).
3. Barnard, G. A., *J. Royal Statistical Soc.* 21, pp. 239–271 (1959).
4. Page, E. S., *Biometrika* 41: pp. 100–115 (1954).
5. Page, E. S., *Biometrika* 42: pp. 243–257 (1955).
6. Truax, H. M., *Chem. Eng. News* 38, No. 12: 50–51 (March 21, 1960).
7. Davies, O. L., *et al.*, "The Design and Analysis of Industrial Experiments," Second Ed., pp. 57–98, New York, Hafner Publishing Co., 1956.
8. Shewhart, W. A. "Economic Control of Quality of Manufactured Product," New York, D. Van Nostrand, 1931.
9. Bennett, C. A. and Franklin N. L., "Statistical Analysis in Chemistry and the Chemical Industry," pp. 663–668, New York, John Wiley, 1954.
10. Meigniez, R., *Revue de statistique appliqué* 6, No. 2: 97–106 (1958).

RECEIVED Feb. 15, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

Studies on Moisture Transmission Rates Through Quarter-Inch Plywood at Different Moisture Content Levels

R. D. ZIEGLER

Rates at which moisture is transmitted through 1/4-in. plywood are reported for different values of the absorbed moisture content of the specimen. The rate is shown to increase rapidly as the average moisture content increases. Indications, on the basis of limited data, are that the same relationship is true for plywood as for insulation board. The rates on plywood were obtained on specimens conditioned to different moisture contents before the tests were started and exposed to different combinations of relative humidity and temperature, but the same vapor pressure gradient, during the tests. These results are in agreement with reports in the literature that the rate of moisture transmission increases with increasing percentages of absorbed moisture for any board made of hygroscopic materials.

THE LITERATURE contains a number of reports to indicate that the rate at which moisture is transferred through boards made with hygroscopic materials varies directly with the absorbed moisture content of the board. This view is presented by Babbitt who states (*3*) that the migration of water vapor through building materials increases with the moisture content and "as the concentration approaches saturation, the increase is very rapid indeed." Babbitt (*1*) in another report, and Joy, *et al.* (*2*), show that the transmission rate through a hygroscopic specimen is greater when

R. D. ZIEGLER, Division of Industrial Research, Institute of Technology Washington State University, Pullman, Wash.

the average humidities to which the two surfaces are exposed is greater than 50%. The reason for this, these authors suggest, is that the board has a higher content of absorbed moisture at the higher humidities.

The manner in which moisture is transferred through wood is a complicated process, and at least two mechanisms are involved. In one, water is transferred as vapor through the coarse capillaries, motivated by the vapor pressure gradient. In the second, water is transferred as bound water which, as Stamm indicates, involves a series of jumps of one molecule at a time from one adsorption site to another. Stamm and Tarkow (*4, 5*) measured, separately, the quantity of moisture transferred by each of these mechanisms through wood in the fiber direction. They concluded that the bound water diffusion coefficient in the fiber direction "increases in an exponential manner with an increase in the average moisture content of the wood."

Previously, Stamm (*6*) had conducted moisture transfer studies on cellophane, which is also a hygroscopic material, and concluded that the rate of transfer of bound water is an exponential function of the fractional water volume of the cellophane. It is interesting to note that Prager and Long (*7*) found that the coefficient of diffusion of hydrocarbons through polyisobutylene also increases exponentially with increasing concentrations of the hydrocarbon in the polymer. Similarly, the electrical conductivity of wood increases exponentially with increasing moisture content (*10*).

Many board materials used in building construction are wood or wood products, and therefore hygroscopic. They absorb or desorb moisture, primarily in response to relative humidity changes. Since the board moisture content varies, it is evident that the rate at which moisture is transmitted through them must also vary.

The literature on this subject contains numerous tables giving data on the moisture transmission rates for different materials. Unfortunately, the data do not include a reference to the moisture content of the specimen at the time of testing. More objectionable is the omission of the relationship between moisture content and rate of transmission. Many of these values were obtained by the dry cup or the wet cup method, and with these it is difficult to determine the moisture content of the specimen at the time the rate data are taken. Furthermore, with these methods the range of relative humidities under which the tests can be conducted is limited. With the dry cup method transmission rates are obtained when the two surfaces are exposed to humidities of 0 and 50%, while with the wet cup method the data are obtained when the two surfaces are exposed to humidities of 50 and 100%. A given specimen usually has a higher transmission rate if it is tested by the wet cup method than it does if tested by the dry cup method, because higher moisture contents are associated with the higher humidities.

The variable nature of the rate of moisture transmission is expressed in the following quotation from a report entitled "Survey and Analysis of the Vapor Transmission Properties of Building Material," by H. M. Whippo and B. T. Arnberg (*11*):

> "It has been concluded that the permeability of a hygroscopic material is a variable, being a function of the average equilibrium water content of the material. Most building materials are hygroscopic....It is therefore evident that a complete presentation of the permeability of a material to water vapor will require the presentation of the relationships between permeability and equilibrium water content of the material plus the relationship between the equilibrium water content of the material and the temperature and vapor pressure of its environment.
>
> "At the present status of information available for most building materials such a complete picture of the phenomenon relating to transmission of water vapor through the materials cannot be given. Investigators determining permeabilities to water vapor, not realizing the importance of hygroscopic properties, failed to determine equilibrium water content or to report sufficient data to allow its subsequent determination Standards have been set up specifying fixed humidity conditions under which the permeability was to be established, ignoring the effects of different humidities upon permeability."

OBJECTIVE

The objective of this research is to help clarify the relationship between the absorbed moisture in a hygroscopic material and the rate at which moisture is transmitted through it. Data are presented showing transmission rates through $^1/_4$-in. plywood at different moisture contents. Similar data were also obtained on insulation board, but on a more limited scale. These are not reported in this paper.

The information was obtained by means of the testing equipment developed at Washington State University, and which has been described in a previous paper (*8*). In this method, the specimen, with a test area of 144 sq. in., is placed horizontally as a common wall between two enclosed chambers. The chamber below it is maintained at a high humidity, and the chamber above it is maintained at a low humidity, both by means of saturated salt solutions. Moisture is therefore transferred upward through the specimen into the upper chamber where it is absorbed by the salt solution. The absorbing solution contains an excess of undissolved salt and is in the form of a paste, so that it can absorb moisture without becoming diluted. This solution is contained in plastic dishes and they are removed from the upper chamber periodically, and are weighed on an analytical balance, and then returned to the chamber. The weight of moisture transferred through the specimen in a given time can therefore be determined, and from this the rate of transmission can be calculated. With this equipment, tests can be obtained with greater accuracy than is possible with other methods because the quantity of moisture transferred through a specimen in a given time is weighed to 0.1 mg. on an analytical balance. Moisture transmission rates can also be determined under any relative humidity condition that can be established with saturated salt solutions, and the conditions can be maintained constant for long periods of time.

PROCEDURE

A series of tests were made with this equipment on $^1/_4$-in. exterior grade plywood to measure the rate of transmission over a range of average moisture contents. The following methods were used to alter the moisture content for each of the rate of measurements:

1. In runs 1 and 2 the specimen was exposed to different relative humidities. In run no. 1 its two surfaces were exposed to 85 and 39% R.H., at 80°F., while the transmission rate was being measured. In

run no. 2, its two surfaces were exposed to 86 and 23% R.H., at 70°F., while the rate was measured. The different humidities used in the two runs produced different average moisture contents in the specimen. These testing conditions were selected because they provided essentially the same vapor pressure gradient in both runs.

2. The specimen was conditioned to different moisture contents, designated condition A and condition B, before the runs were started and runs 1 and 2 were both made under each initial condition. In condition A the specimen was ovendry as run no. 1 was started, and when this was finished, it was oven-dried again before run no. 2 was started. In condition B the specimen was oven-dried, then re-conditioned to 7.5% moisture before run no. 1 was made. After this test, the specimen was oven-dried again, then re-conditioned to 7.5% moisture before run no. 2 was made.

When initially ovendry, both surfaces of the specimen approached their equilibrium moisture contents from the dry direction during both runs. When conditioned to 7.5% moisture initially, one surface approached its equilibrium moisture content from the dry direction while the other surface approached it from the wet direction. Because of hysteresis, the average moisture content, after equilibrium had been established, was different for each of these conditions. To provide a measure of replication, two separate plywood specimens were tested by the four procedures outlined.

In this work the moisture content of each surface of the specimen was obtained indirectly by exposing smaller-sized pieces of the plywood to the two humidities that were used in the test. These smaller pieces were $3^1/_2$ by 4 in. in size, and were divided into two sets. Each set was placed into a separate desiccator at the time that a rate of transmission test was started. The humidity is one desiccator was controlled by the same type of salt solution that was used in the lower chamber of the tester, and the humidity in the other was controlled by the solution used in the upper chamber of the tester. In this manner, the smaller sets were exposed to the same humidities as the upper and lower surfaces of the test specimen. Before placing into the desiccators, the sets were preconditioned in the same manner as the transmission rate specimens so that all of the pieces for a particular test had exactly the same moisture content when the test started.

The small sets were removed from their desiccators, placed in weighing boxes, and weighed daily as the experiments proceeded so that their moisture contents could be calculated and the changes observed. It was assumed that the moisture content of each surface of the transmission specimen during the test was the same as that of the respective smaller pieces. Daily readings were also taken of the quantity of miosture transferred through the specimen.

It has been shown that when a hygroscopic board has a different moisture content on each of its two surfaces, the moisture variation through it from one surface to the other is parabolic. Therefore the average moisture content is considered to be equal to two-thirds of the difference between the moisture content in the two surfaces plus the lowest value (*6*). This method was used to calculate the average values in this report.

Table I. Rates of Moisture Transmission Induced by Different Relative Humidities and Different Preconditioning Treatments Correlated with the Final Average Specimen Moisture Content

Condition of specimen	*Specimen 1* Run 1[a]	*Specimen 1* Run 2[b]	*Specimen 2* Run 1[a]	*Specimen 2* Run 2[b]
A. Specimen ovendry at the beginning of the test				
Grams transmitted per 24 hr./sq. ft.	1.65	1.20	1.35	1.10
Final average moisture content, %	10.7	9.7	10.4	9.8
B. Specimen conditioned to 7.5% moisture at the beginning of the test				
Grams transmitted per 24 hr./sq. ft.	1.60	1.91	1.55	1.67
Final average moisture content, %	10.5	11.2	10.8	10.7

[a] Run 1, R.H. = 85% and 38% at 80°F.
[b] Run 2, R.H. = 86% and 23% at 70°F. The vapor pressure gradient was the same in all tests.

RESULTS

1. Table I shows the rates of moisture transmission, after equilibrium had been established, together with the average moisture content of the specimens.

These results show a wide variation in transmission rate, even for the same specimen, in spite of the fact that all tests were made at essentially the same vapor pressure gradient. However, when the transmission values are plotted against the average moisture content, as shown in Fig. 1, a definite relationship between the two becomes apparent. The transmission rate seems to be a straight-line function, with moisture content within the range studied in this experiment. It is startling to note that the rate doubles when the absorbed moisture increases from approximately 9.4 to 11.3%. Further experimental work is planned in an attempt to discover the factors that are responsible for this behavior.

2. It has been observed that the length of time required to attain a constant rate of moisture transmission during a test may be as long as six weeks. This is to be expected in some cases because the time is required for the specimen to arrive at its equilibrium moisture content when exposed to the test humidities. The actual time required depends upon the humidities to which it is exposed and upon the content of absorbed moisture in the specimen at the time a test is started. A specimen that is ovendry initially requires a considerably longer time than one that contains some moisture.

As these equilibrium conditions are approached, during the course of an individual test, there is a definite relationship between the transmission rate at any given time and the average absorbed moisture content at that time. Figure 2 shows this relationship for a specimen that was ovendry when it was assembled in the tester.

Since this specimen was ovendry initially, it was necessary for it to absorb moisture to come up to its equilibrium value. The moisture it absorbed was taken from the saturated salt solutions used to control the humidities, and therefore these solutions lost weight. The weight loss is reflected in negative values for the rate of transmission at the beginning of the test, which are shown in Fig. 2. After the transmission rate becomes positive, the increase in rate with increas-

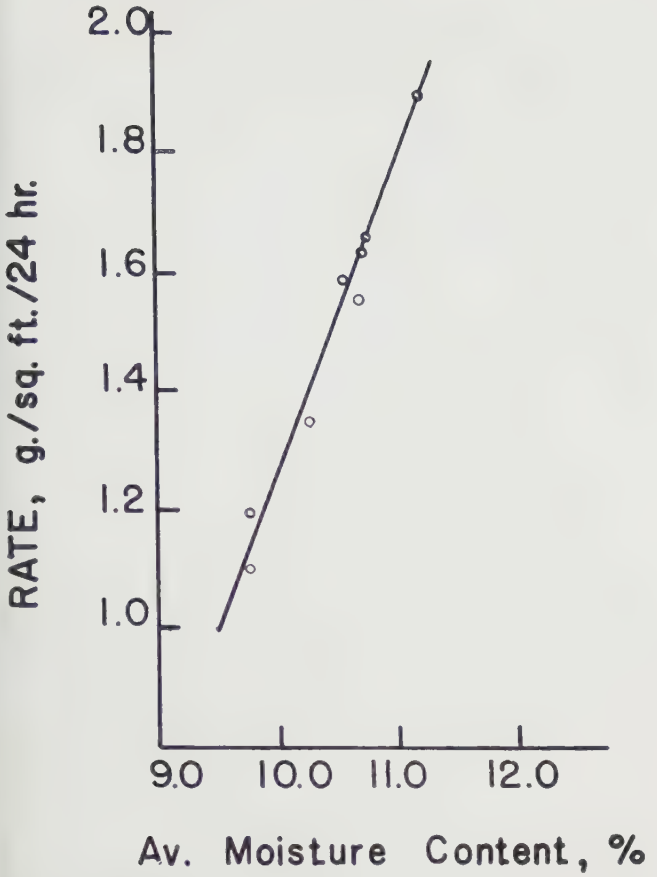


Fig. 1. Transmission rate versus average moisture content

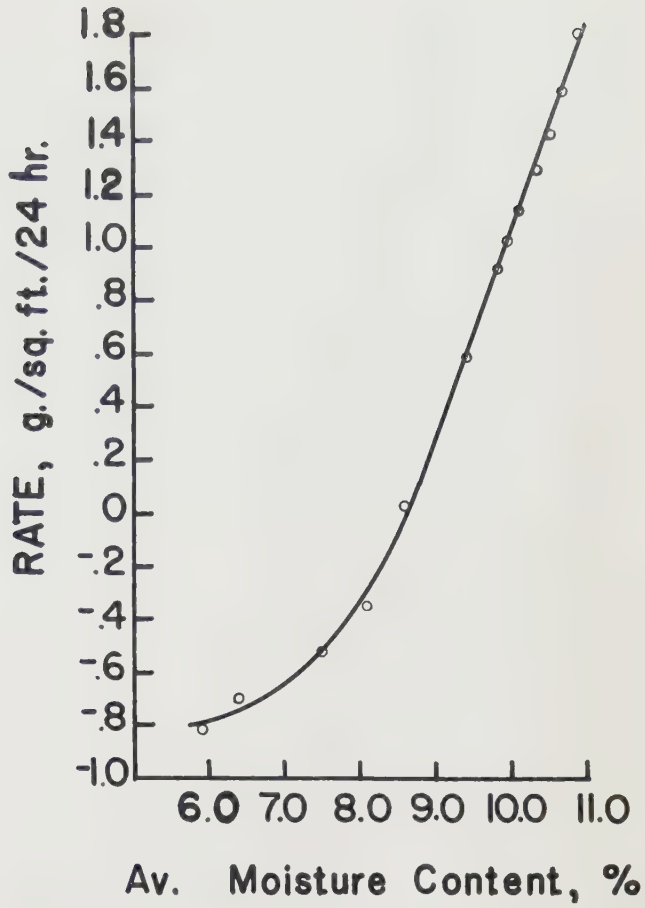


Fig. 2. Transmission rate versus average moisture content during a test

ing moisture content becomes very rapid. It is possible that if this work were extended over a wider range of values, it would approach the exponential relationship found by other workers. However, it is also possible that the glue lines in the plywood may affect the results, and disrupt this relationship.

Graphs similar to Fig. 2 were drawn for all the tests shown in Table I, and all of them fit very closely onto this curve. The specimens that had been conditioned to 7.5% moisture initially, however, will not have the negative values that are shown because it is not necessary for them to absorb moisture from the salt solution in the upper chamber of the tester. For these specimens, the curves are shorter, but they can still be placed on the curve shown in Fig. 2.

The fact that the curves fit together is very significant. It indicates the close relationship between the transmission rate and the average moisture content for these two specimens when tested under a variety of conditions. These two were cut from the same 4 by 8 ft. panel. The general shape of the curve will probably apply to any $^1/_4$-in. plywood, but it has not been determined whether the particular values shown in Fig. 2 will apply to other specimens.

CONCLUSION

By altering the initial moisture content, and by altering the temperatures and relative humidities used in the test, it is possible to obtain different moisture transmission rates on the same specimen, even though there is no difference in the vapor pressure gradient at which the tests are made. However, there is a definite relationship between these values and the average moisture content of the specimen at the time of the tests.

Moisture Transmission Through Insulation Board

The results reported in this paper was obtained on $^1/_4$-in. plywood. Other work in this laboratory on a more limited scale has shown that the absorbed moisture content of insulation board also affects the rate at which moisture is transmitted through it. If the absorbed moisture content is higher, the rate of moisture transmission will be greater. This would indicate that if an insulation board is to be used in a location where the rate of transmission should be low its water absorption value should also be as low as possible.

Insulation board has an advantage over other boards because it can be well sized during its manufacture to reduce the amount of water it can absorb. Boards whose water absorption value cannot be improved during manufacture would have to be coated with waterproofing agents in a separate operation. A well-sized insulation board could be used as it is received.

LITERATURE CITED

1. Babbitt, J. D., National Research Council Bulletin No. 2, Ottawa, Ontario, Canada.
2. Joy, F. A., Queer, E. R., and Schreiner, R. E., Engineering Experiment Station Bulletin 61, The Pennsylvania State College.
3. Babbit, J. B., Building Research Advisory Board Conference Report No. 4, 1952.
4. Stamm, A. J., Tarkow, H., *Forest Products J.* 10: 247 and 323 (May and June, 1960).
5. Stamm, A. J., *Forest Products J.* 9: 27 (Jan., 1959).
6. Stamm, A. J., *J. Phys. Chem.* 60: 83 (Jan., 1956).

7. Prager, S. and Long, F. A., *J. Am. Chem. Soc.* 73: 4072–4075 (Sept., 1957).
8. Ziegler, R. D., *Tappi* 40: 881 (1957).
9. Barrer, R. M., "Diffusion In and Through Solids," Cambridge University Press, 1951.
10. Stamm, A. J., *Ind. Eng. Chem., Anal. Ed.* 1: 94–97 (1929).
11. Whippo, H. M. and Arnberg, B. T., "Survey and Analysis of the Vapor Transmission Properties of Building Materials," Engineering Experiment Station, University of Colorado, Boulder, Colo., 1955.

Received Jan 23, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

DISCUSSION

F. A. Joy (Prof. of Engineering Research, The Pennsylvania State University): The conclusion that water vapor transmission is a function of the water content of plywood is consistent with accepted principles that the permeability and the water content of wood are both functions of the exposure conditions (primarily R.H.). Therefore, a functional relation exists between them. The data presented suggest that this relation is linear and that it is more reliable for wood than the basis discussed earlier (*1*).

I would like to ask whether the plywood was 3-ply Douglas-fir, and what adhesive it contained? It is doubtful whether the data or the conclusions can be applied to a different sandwich or to natural wood. Lacking complete data on fir, it may be relevant that results on sugar pine (*2*) show permeability about three times the average value reported here. This suggests that the adhesive may have been more important than the wood in these tests. It is also not clear whether the specimens suffered any permanent change during the four tests on each. A fifth test, duplicating the first, would be very helpful.

The range of "final average moisture content" is narrow (not over 1.5%) and the means of determining moisture content is indirect and questionable. To establish the stated conclusion, it is essential that the water content be measured with as much precision as the WVT rate.

The method of determining WVT is basically adequate though it would be helpful if the rate of water evaporation from the source were also measured for comparison to the gain by the sink. Figure 2 shows the progress of *emission* from the specimen (not its *transmission*) during the test. It is not clear how it was determined that a steady state existed at the end of each test. Incomplete equilibrium would, of course, invalidate the result.

The author mentions the "hysteresis effect," referring to moisture content. In consequence, the data indicate a hysteresis effect in WVT, and these phenomena appear to be fundamental to the stated conclusion. In two tests on specimen 1, with the same exposure, the 7.5% initial moisture content allowed 59% higher WVT than the dry start. Our work on other materials does not reveal a hysteresis effect in WVT. I would therefore like to ask if this is peculiar to wood and if a unique transfer mechanism is indicated.

LITERATURE CITED

1. Joy, F. A., *Tappi* 41, No. 10: 168A (Oct., 1958).
2. Reference *2* of the basic paper.

R. D. Ziegler: Professor Joy is correct in stating that the actual numerical data reported in this paper for 1/4-in. plywood may not apply to another sandwich or to natural wood. We recognize the existence of considerable variability among specimens, even of the same material, and therefore the data obtained in these limited tests may not apply generally to all 1/4-in. plywood. We do feel, however, that the data gives an indication of the values to be expected, and that the transmission rate through plywood increases linearly, within limits, as the specimen moisture content increases. It would be desirable to conduct a number of these tests and from the numerical data obtained to develop a formula for correcting an observed permeability, obtained under a standard testing condition, to the rate that will prevail for the same specimen at some other moisture content.

The plywood used in this work was 1/4-in., 3-ply Douglas-fir, exterior grade. No doubt, as Professor Joy points out, the glue lines have a definite effect on the transmission rate. Currently we are beginning a series of tests on solid wood specimens. When these data are obtained, we will be in a better position to make a comparison between plywood and solid wood to determine the precise effect of the glue lines.

Since this paper was prepared, additional data have been obtained on other plywood specimens under other test conditions. The straight line relationship between the average moisture content and the transmission rate, expressed as grains per sq. ft. × hr. × in. Hg, is also evident in this work. In these tests the average moisture content varied from 7.5 to 10.5%, which is a range of 3%. The extent of the range of average moisture content values over which this relationship will apply is not known, but it is doubtful that it applies over the full range.

As stated, the moisture content at each surface of the specimen was determined by exposing separate pieces of plywood (cut from adjacent areas of the test specimen), to the same relative humidities that were used on the two sides of the specimen. These pieces were weighed periodically. The salt solution mixtures to which they were exposed were exactly the same as the solutions used on each of the two sides of the test specimen. Therefore, the smaller specimens were assumed to have the same moisture content as each of the two surfaces of the test specimen, since both were exposed to the same relative humidities. This method of determining moisture content is indirect, as Professor Joy says, but it was believed to have sufficient accuracy.

The steady-state condition was considered as established in these tests when the transmission rates, which were obtained daily, remained constant for a period of one week or more. The values reported in Table I and Fig. 1 are those obtained during that period. Since the transmission rate remained constant, this would indicate that it is a true transmission rate, rather than being an *emission* rate.

It appears that the moisture content of a specimen at steady-state has different effects on the rates of transmission for different materials. Dr. Stamm (*1*) reports that for uncoated cellophane the diffusion constant increases exponentially with an increase in the fractional water volume of the specimen.

Rouse (*2*) reports tests on a nylon film in which the diffusion coefficient increases with increasing concentration of moisture. He also reports tests on a polyethylene film in which the diffussion coefficient apparently decreases with increasing moisture concentrations.

The effect of the initial moisture content of the specimen on its transmission rate is a factor that requires more study. As reported in this paper, plywood with initial moisture contents of 0 and 7.5% has transmission rates proportional to the average moisture content under steady-state conditions. Other work in this laboratory (*3*) has indicated that a plywood specimen with a moisture content in the neighborhood of 20% when the test is started will have a transmission rate as much as six times the rate the same specimen would have if it were ovendry when the test began. In both cases, these are steady-state conditions, and the daily values remain constant. Professor Joy reports (*4*) that the starting moisture content of a 10-mil cellulose acetate film has little or no effect on its vapor transmission rate when a steady-state is reached. A study of the factors involved in these cases may shed light on the mechanism of moisture transmission through different materials.

LITERATURE CITED

1. Stamm, A. J., *J. Phys. Chem.* 60: 83 (Jan., 1956).
2. Rouse, P. E., Jr., *J. Am. Chem. Soc.* 69, No 5: 1068 (May, 1947).
3. Ziegler, R. D., *Tappi* 43, No. 11: 913 (Nov., 1960).
4. Joy, F. A., Private communication.

ASSOCIATION NEWS AND EVENTS

National Conferences

1961

Sixth Deinking Conference, Oct. 4–6, 1961, Hotel Harris, Kalamazoo, Mich.

Sixteenth Plastics-Paper Conference, Oct. 9–11, 1961, French Lick Sheraton Hotel, French Lick, Ind.

Sixteenth Engineering Conference, Oct. 15–19, 1961, Shoreham, Hotel, Washington, D. C.

Fifteenth Alkaline Pulping Conference, Nov. 1–3, 1961, Rice Hotel, Houston, Tex.

1962

Forty-seventh Annual Meeting, Feb. 18–22, 1961, Commodore Hotel, New York, N. Y.

Thirteenth Coating Conference, May 14–16, 1962, Netherland-Hilton Hotel, Cincinnati, Ohio.

Thirteenth Testing Conference, Sept. 18–20, 1962, Benjamin Franklin Hotel, Philadelphia, Pa.

Seventeenth Plastics-Paper Conference, Oct. 8–11, 1962, Statler-Hilton Hotel, Boston, Mass.

Seventeenth Engineering Conference, Oct. 14–19, 1962, Queen Elizabeth Hotel, Montreal, Que.

Twelfth Corrugated Containers Conference, Oct. 23–26, 1962, Statler-Hilton Hotel, Boston, Mass.

Sixteenth Alkaline Pulping Conference, Oct. 31, Nov. 1–2, 1962, DeSoto Hotel, Savannah, Ga.

1963

Fourteenth Coating Conference, May 19–22, 1963, Concord Hotel, Kiamesha Lake, N. Y.

Thirteenth Corrugated Containers Conference, Oct. 22–25, 1963, Statler-Hilton Hotel, Detroit, Mich.

Eighteenth Engineering Conference, Oct. 28–31, 1963, Netherland-Hilton Hotel, Cincinnati, Ohio.

Other Meetings

On Sept. 28, 29, and 30, 1961, the Chemical Division of the American Society for Quality Control is holding its Fifth Annual Chemical Conference at the Daniel Boone Hotel in Charleston, W. Va.

Technical Section of the British Paper and Board Makers' Association, Sept. 25–29, 1961, Symposium: The Formation and Structure of Paper, Oxford, England.

Papirindustriens Tekniske Forening, Dec. 5–6, 1961, Technical Convention, Oslo, Norway.

Delaware Valley Program

The Delaware Valley Section has announced the following schedule of meetings for 1961–62:

September 21, 1961—Visit to Scott Paper Co. research laboratory at Philadelphia Airport (2 p.m.). Dinner meeting at Lamlis Tavern (6:30 p.m.) "Wet-End Process Control," by P. H. Hershey, P. H. Glatfelter Co., Spring Grove, Pa.

October 26, 1961—(Manufacturers Country Club, Oreland, Pa.) Panel discussion of "The Optical Properties of Paper."

November 16, 1961—(Manufacturers Country Club) Subject—"Drying of Paper."

January, 1962—(Engineer's Club, Philadelphia, Pa.) Subject—"Evolutionary Operation." (Date to be announced.)

March 22, 1962 —(Manufacturers Country Club) E. J. Albert Award—technical papers.

April 27, 1962—(Riegel Ridge Community House) Tour of the mill of Riegel Paper Corp., Milford, N. J.

May, 1962—(Annual Graphic Arts Conference) Time and place to be announced.

Virginia-Carolina

September 29–30, 1961—Meeting Friday evening, College Inn, Raleigh, N. C.; visit paper school at North Carolina State College.

December 1, 1961—Visit converter in Richmond, Va., in afternoon. Dinner and papers in evening at the Jefferson Hotel.

March 23, 1962—Papers in afternoon session; dinner and papers in evening at John Marshall Hotel, Richmond, Va.

May 17, 1962—Papers in evening session, Canton, N. C. Champion mill visit Saturday morning, May 18.

Kalamazoo Valley

The Kalamazoo Valley Section has announced the following schedule of meetings for 1961–62:

October 6, 1961 (Hotel Harris, Kalamazoo, Mich.). Deinking Conference Dinner Meeting.

November 2, 1961 (Inmans Restaurant, Galesburg, Mich.). "Sales Technical Relationships," by H. W. Parnass, Sales Manager, Watervliet Paper Co., Watervliet, Mich.

December 7, 1961 (Hotel Harris). "Pigment Coating" (Afternoon-Evening Session).

January 18, 1962 (Hotel Harris). Papermakers Get-Together (Joint with PIMA).

March 1, 1962 (Hotel Harris). "Recent Developments in the Graphic Arts."

April 5, 1962 (Hotel Harris). "Chemi-Mechanical Pulping" (Afternoon-Evening Session).

May (date to be announced) (Gull Harbor Inn). "Recognition Night."

June (date to be announced) (Gull Lake Country Club). Fun Day. Joint with PIMA.

Fifteenth Alkaline Pulping Conference

The Fifteenth Alkaline Pulping Conference is scheduled for Nov. 1–3, 1961 at the Rice Hotel in Houston, Texas.

Your attention is invited to the August issue of *Tappi* which lists many of the papers to be presented as well as other pertinent details.

Those planning to attend the Conference should write to

TAPPI 15th Alkaline Pulping Conference
Rice Hotel
Houston, Texas

for hotel reservations and state the time and date of arrival and departure.

Empire State (Northern District)

The Northern District of the Empire State Section has announced the following schedule of meetings for 1961–62. All meetings will be held at the Woodruff Hotel, Watertown, N. Y., unless otherwise indicated.

September 21, 1961 (Edgewood Resort Motel, Alexandria Bay, N. Y.). "Modern and Future Trends in Coating," by Hugh H. Lavery, International Paper Co., Palmer, N. Y. (beginning at 2:00 p.m.)

October 12, 1961. Mill visit (to be announced).

November 9, 1961. Executives' Night.

December 14, 1961. "High Density Bleaching of Groundwood," by A. D. Armstrong, St. Regis Paper Co., Deferiet, N. Y.

January 11, 1962. Students' Night.

February 8, 1962. "Headbox Hydraulics" (speakers to be announced).

March 8, 1962. Junior Award Papers Competition.

April 12, 1962. "Wet Strength Resins for Paper" (Speaker to be announced). Joint meeting with Beaver Falls Chapter A.I.C.

May 10, 1962. Annual Meeting and Dinner-Dance.

Report of 1962 Nominating Committee

The Nominating Committee has presented the following slate of candidates for officers and executive committee members of the Association.

President (1 Year): Harold M. Annis, vice-president in charge of research, Oxford Paper Co., New York, N. Y.

Vice President (1 Year): John C. Wollwage, general manager, manufacturing processes, Kimberly-Clark Corp., Neenah, Wis.

Executive Committee (3 Years):

George J. Brabender, asst. plant manager, Marathon Southern Corp., Naheola, Ala.

Harold C. Brill, section manager, Technical Service, Pigments Dept., E. I. du Pont de Nemours & Co., Inc. Wilmington, Del.

Jack McK. Limerick, director of research, Bathurst Power & Paper Co., Montreal, Que., Canada.

Richard T. Trelfa, executive vice-president, Perkins-Goodwin Co., New York, N. Y.

Mail ballots will be submitted to active and corporate members of the Association prior to the 1962 annual meeting.

According to Article VII, Section 3 of the Association Constitution other nominations, if signed by at least 25 voting members may be submitted to the Executive Secretary of the Association on or before November 20. If each nomination so made is accepted in writing by the nominee, the name shall be placed on the official ballot.

Principals of the Nominating Committee are J. J. Thomas, S. D. Warren Co., Cumberland Mills, Me., C. E. Brandon, Miami University, Oxford, Ohio, K. G. Chesley, Crossett Paper Mills, Crossett, Ark., F. W. O'Neil, New York State College of Forestry, Syracuse, N. Y., and E. R. Padavic, Container Corp. of America, Santa Clara, Calif.

Mr. Brabender was a former member of the Association Executive Committee. Mr. Brill was formerly chairman of the Delaware Valley Section. Mr. Limerick was a former chairman of the Alkaline Pulping Committee and a chairman of The Technical Section of the Canadian Pulp and Paper Association. Mr. Trelfa is general chairman of the Coating and Graphic Arts Division and a past chairman of the Kalamazoo Valley Section.

R.P.I. Luncheon

Alumni of R.P.I. attending the 16th Engineering Conference being held in Washington, D. C., October 10–19 at the Shoreham Hotel will have a luncheon Thursday noon, the 19th. Details may be obtained from the hotel or registration desk.

Study Group of European TAPPI Members

The Seventh Annual Congress of the Study Group of European TAPPI Members was held at Brussels, Belgium on June 12–15, 1961. There were 209 registrants and 39 ladies in attendance.

The following papers were presented:

"The Production of Specialty Coated Papers," by O. S. Dunnett.
"La Fabrication des Cartons," by G. de la Tullaye.
"A New Fiber-Polymer Complex," by G. Rausing.
"The Joint Use of Paper and Plastics," by J. R. Young.
"Brightness Measurements," by R. Bernard.
"The Relations Between Properties of a Pulp Suspension and Paper Made from It," by A. H. H. van Royan.
"Inverform," by L. A. Lawrence.
"The Selective Reintroduction of Moisture into the Paper Web," by F. Church and R. Gardner.

Note: Preprints of the aforegoing papers may be obtained (at £ 1 per set) from I. F. Hendry, Wiggins, Teape & Co., Ltd., Beaconsfield, Bucks, England.

A panel discussion on paper-plastics relationship followed. The panelists were: F. Engel, Saint-Gobain; T. H. Nevrell, A/B Bonnier Foretagen D. Schock Zellstofffabrik Waldhof; H. Wilfinger, Badische Anilin; and J. H. Wilson, Imperial Chemical Industries.

Mill Visits

A visit was made to the plant of Papeteries de Genval where Balatum floor covering is manufactured.

A second visit was made to the mill of De Naeyer where grease-proof and glassine papers are made from special sulfite pulps made at the mill for wet beating.

The third visit was made to the Langebrugge newsprint mill of Papeteries de Belgique. Here was seen one of the newest groundwood mills in Europe and a new Walmsley Beloit paper machine, equipped with cross-web moisture control. Of special interest was the Lippke moisture addition system on the Langerbrugge machine. A demonstration of this was given following the technical paper presented by Gardner and Church on the same subject.

International Attendance

Countries represented at the Congress were Austria, Belgium, Czechoslovakia, England, Finland, France, Germany, Holland, Hungary, Ireland, Italy, Nigeria, Norway, Sweden, Switzerland, United States, and Yugoslavia.

At the 7th meeting of the European Study Group: Mr. Thiry, Thiry & Co.; Mrs. Wollwage, Mr. Loos, Papeteries de Genval, and president of the Belgium Papermakers Association; Dr. Muller, president, Study Group of European TAPPI Members; Mr. Wollwage, vice-president, TAPPI; Mrs. H. F. Rance; and Mr. Vincent, Papeteries de Belgique

to strengthen a guarantee of TITANIUM DIOXIDE QUALITY

This new electronic instrument is an Autrometer —a unique X-ray fluorescence spectrometer in the product-testing laboratory of the New Jersey Zinc Company.

The Autrometer determines chemical composition of pigments and metals—accurately— in a matter of minutes. It is a valuable aid in the control of chemical purity of Horse Head titanium dioxides for the paper industry.

The Autrometer is just one more instrument added to New Jersey Zinc's highly efficient product-control system—to safeguard a century-old reputation for uniform quality in pigments—to strengthen a guarantee to the paper industry that Horse Head Titanium dioxides are the most dependable titanium dioxides available.

HORSE HEAD PRODUCTS ®

HORSE HEAD® TITANIUM DIOXIDE

THE NEW JERSEY ZINC COMPANY, 160 Front St., New York 38, N. Y.

Founded 1848

Also distributed by **BULKLEY DUNTON PULP CO. INC.** • New York, N. Y. • Kalamazoo, Mich. • San Francisco, Calif.

Social Events

Members attended a party given by Thiry & Cie in the Karreveld Castle in Brussels, a party in the Brussels Town Hall and a dinner in the Galerie Louise in Brussels. During the mill visits luncheons were held in the Chateau de Tervinen, one of the oldest Belgian royal palaces. The ladies made a coach tour of Brussels and visited Ghent. There was a general tour of Bruges by boat.

Business Meeting

F. M. Muller of the Netherlands Experiment Station for the Utilization of Straw resigned as president and was succeeded by T. H. Nevrell of A/B Bonnier Foretagen of Sweden. I. F. Hendry of Wiggins, Teape & Co., England continued as secretary-treasurer.

The executive committee now consists of the officers and K. Adamik, H. Benedite, P. Ceuterick, E. Cirla, R. Naville, H. F. Rance, G. Vamos, and Louis Lhoest.

John Wollwage, vice-president of TAPPI was present and participated in the meeting.

The details of preparing for the meeting were handled by Cobelpa, the Belgian Paper and Pulp Makers Cooperative and M. Ceuterick of Papeteries de Belgique.

The next meeting will be held jointly with Eucepa at Stockholm, Sweden on Sept. 24–29, 1962. Tenative plans indicate that the 1963 conference will be held in France, and the 1964 conference in Frankfurt, Germany in conjuction with Achema.

Sixteenth Plastics-Paper Conference

TENTATIVE PROGRAM

French Lick-Sheraton Hotel, French Lick, Ind. Oct. 9–11, 1961.

SUNDAY, OCT. 8, 1961

12:00 noon—8:00 p.m. ***Registration (Lobby)***
5:00 p.m. ***Division Officers Meeting (Parlor 107)***

MONDAY, OCT. 9, 1961

7:30 a.m.—9:00 a.m. ***Authors' Breakfast (Mural Room)***
8:00 a.m.—5:00 p.m. ***Registration (Lobby)***
9:00 a.m. ***Session I—Plastics Committee (Convention Hall)***

W. F. Nolan, Federal Paper Board Co., Inc., Bogota, N. J., *Vice-Chairman*

1-1. "Fundamentals of 'Flow' or 'Curtain' Coating," by W Sandowski, Joyce Research & Development Corp., Valley Stream, Long Island, N. Y.

1-2. "Plastics in Deinking," by J. L. Clouse, Oxford Paper Co., West Carrollton, Ohio

1-3. "Application and Properties Vinylidene Chloride Emulsion Polymers Applied to Paper," by R. F. Avery, W. R. Grace & Co., Cambridge, Mass.

1-4. "Blends of Ethylene/Vinyl Acetate Copolymers and Wax as Flexible Paper Coatings," by S. T. Lamar, R. H. Beeman, and E. P. Czerwin, E. I. du Pon de Nemours & Co., Inc., Wilmington, Del.

2:00 p.m.—3:30 p.m. ***Committee Meetings***
Plastics Committee (Parlor B)
Plastic Laminates Committee (Parlor C)
Wet Strength and Interfiber Bonding (Parlor G) Committee (Parlor G)
(Parlor D)
(Parlor E)
(Parlor T)

4:00 p.m.—5:30 p.m. ***Committee Meetings***
Extrusion Coatings Committee (Parlor B)
Synthetic Fiber Committee (Parlor G)
Cataloging of Paper Plastics Combinations—CA 803 (Parlor F)
(Parlor C)
(Parlor D)
(Parlor E)

6:30 p.m. ***Reception (Convention Hall)***
7:30 p.m. ***Banquet (West Dining Room)***

Speaker: B. Golding, School of Chemical Engineering, Purdue University, Lafayette, Ind.
Subject: "Paper versus Plastic versus Paper and Plastic"

TUESDAY, OCT. 10, 1961

7:30 a.m.—9:00 a.m. ***Authors' Breakfast (Mural Room)***
8:00 a.m.—5:00 p.m. ***Registration (Lobby)***
9:00 a.m. ***Session II—Wet Strength & Interfiber Bonding (North Foyer)***

C. S. Maxwell, Chemical Consultant, Old Greenwich, Conn., *Chairman*

2-1. "The Preparation of Wet-Strength Paper under Neutral or Alkaline Conditions," by G. I. Keim and A. C. Schmalz, Hercules Powder Co., Wilmington, Del.

2-2. "Wet End Additions of Separated Corn Starch Fractions," by M. L. Cushing, D. T. Ellerman, and R. G. Martin, Jr., A. E. Staley Manufacturing Co., Decatur, Ill.

2-3. "High Efficiency Wet-Strength Production by Dialdehyde Starch in Closed White Water Systems," by B. T. Hofreiter, G. E. Hamarstrand, D. J. Kay, and C. E. Rist, U. S. Department of Agriculture, Peoria, Ill.

2-4. "Polyacrylamide As a Stock Additive," by W. T. Linke, American Cyanamid Co., Stamford, Conn.

2-5. "The Preparation and Properties of Paper Grafted by the Ceric Ion Technique," by E. Schwab, E. I. du Pont de Nemours & Co., Inc.; V. T. Stannett, College of Forestry, Syracuse University, Syracuse, N. Y.; D. H. Rakowitz and J. K. Magrane, American Cyanamid Co., Stamford, Conn.

2:00 p.m. ***Session III—Use of Plastics with Paper and Board Materials (Convention Hall)***

E. J. Kane, Thomas J. Lipton, Inc., Hoboken, N. J., *Chairman*

3-1. "Paper Plastics Uniforms," by G. R. Thomas, Quartermaster Research & Engineering Command, U. S. Army, Natick, Mass.

3-2. "Beam Test for Wet Strength Was Impregnation," by D. S. Brown, The Atlantic Refining Co., Philadelphia, Pa.

3-3. "Corrugated and Plastics: Their Common Market," by R. S. Smith, Packaging Div., Olin Mathieson Chemical Corp., West Monroe, La.

SIXTH DEINKING CONFERENCE

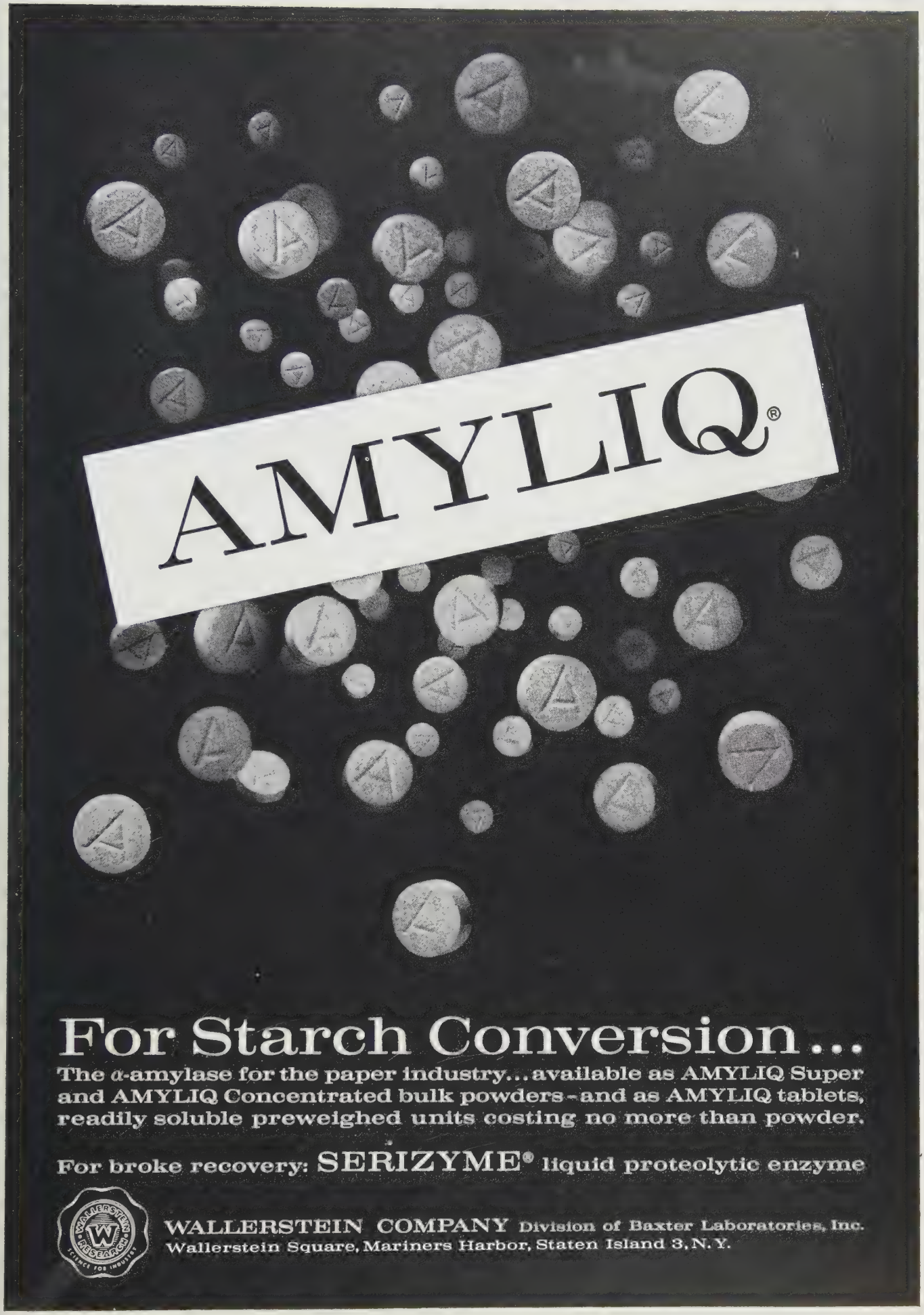
The Sixth Deinking Conference is scheduled for Oct. 4–6, 1961 at the Hotel Harris in Kalamazoo, Mich., and has as its theme "Bleaching of Deinked Stock."

Your attention is invited to the August issue of *Tappi* which lists the papers to be presented as well as other pertinent details.

Those planning to attend the Conference should write to:

TAPPI 6th Deinking Conference
Hotel Harris
Kalamazoo, Michigan

and state the time and date of arrival and departure.


AMYLIQ®
For Starch Conversion...
The α-amylase for the paper industry...available as AMYLIQ Super and AMYLIQ Concentrated bulk powders–and as AMYLIQ tablets, readily soluble preweighed units costing no more than powder.
For broke recovery: SERIZYME® liquid proteolytic enzyme
WALLERSTEIN COMPANY Division of Baxter Laboratories, Inc.
Wallerstein Square, Mariners Harbor, Staten Island 3, N.Y.

3-4. "Refrigerated Container Requirements," by A. C. Beardsell, The Mead Corp., Cincinnati, Ohio

3-5. "Permeability Series versus Practice in Reference to Liquid Packages" by A. D. Galbraith, Riegel Paper Corp., Milford, N. J., and E. A. Kitchen, Lehigh University, Bethlehem, Pa.

12:00 noon — *1962 Conference Planning Meeting (Mural Room)*

WEDNESDAY, OCT. 11, 1961

7:30 a.m.—9:00 a.m. — *Authors' Breakfast (Mural Room)*

8:00 a.m.—5:00 p.m. — *Registration (Lobby)*

9:00 a.m. — *Session IV—Synthetic Fibers Committee (Convention Hall)*

H. E. Shearer, American Viscose Corp., Marcus Hook, Pa., *Chairman*

Panel Discussion—The Growing Importance of Man-Made Fibers to the Paper Industry

Moderator: H. E. Shearer

Panel Members: W. K. Saunders, Kimberly-Stevens Corp., New York, N. Y.; D. G. Bannerman, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.; W. R. Wilson, American Viscose Corp., New York, N. Y.; H. A. Spencer, Knowlton, Bros., Watertown, N. Y.; W. F. Reynolds, American Cyanamid Co., Stamford, Conn.; C. L. Hazelton, Blandy Paper Div., Hollingsworth & Vose Co., Schylersville, N. Y.

12:00 noon — *Conference Luncheon (West Dining Room)*

2:00 p.m. — *Session V—Extrusion Coating Committee (Convention Hall)*

J. S. Thornton, Frank W. Egan & Co., Somerville, N. J., *Chairman*

5-1. "Heating Capacity Limitations of Extruder Screws," by B. H. Maddock, Union Carbide Plastics Co., Bound Brook, N. J.

5-2. "A Mathematical Analysis of the Coating Variables in Extrusion Coating," by, E. I. du Pont de Nemours & Co., Inc.

5-3. "Process Variables in Coating Paper and Foil," by Reynolds Metals, and E. I. du Pont de Nemours & Co., Inc.

Sixteenth Engineering Conference

The Sixteenth Engineering Conference is scheduled for Oct. 15–19, 1961 at the Shoreham Hotel in Washington, D. C. and will place emphasis on the theme "Cost Reduction Through Engineering."

The program, subject to a few changes, has been previously published in the July 1961 issue of *Tappi*. The following additional papers will also be presented:

"Overlay Testing at Time of Application," by H. Y. Rienhoff, Alloy Cladding Co., Inc., Baltimore, Md.

Panel Discussion—High Performance Hoods for Coating Drying; S. G. Holt, Moderator, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

"Analog Computer Analysis of a Non-Linear Temperature Control System," by K. I. Mummé, Kimberly-Clark Corp., Neenah, Wis.

"Stock Preparation Analysis," by J. Lewis and D. W. Danforth, Pulp and Paper Research Centre, Inc., Lawrence, Mass.

"The Development of an Automatic Freeness Controller," by D. G. Sutherland, The Black-Clawson Co., Middletown, Ohio.

"Simulation Models in Operations Research," by E. Naddor, Johns Hopkins University, Baltimore, Md.

"Combined Effects of Advertising, Pricing and Distribution in the Chemical Industry," by M. Halbert, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

"Applications of Operations Research in the Paper Industry," by R. H. Caston, Kimberly-Clark Corp., Neenah, Wis.

"Multi-Projects Scheduling," by W. Dorfman, Corp. for Economic & Industrial Research, Arlington, Va.

"The Electronic Computer 'It Counts'," by F. A. Reed, The Rust Engineering Co., Pittsburgh, Pa.

Those planning to attend the conference should write to:

TAPPI 16th Engineering Conference
Shoreham Hotel
Washington, D. C.

and state the time and date of arrival and departure.

Your attention is called to the UPI announcement that all 2,000 United States commercial airliners will be grounded during a 12-hour air defense test in October. The test, called "Sky Shield II," will result in the canceling of all scheduled airline flights from noon to midnight, Saturday, Oct. 14.

Location of TAPPI Annual Meetings

Arrangements have been completed to hold the annual meetings of the Technical Association of the Pulp and Paper Industry at the New York Hilton Hotel, beginning in 1964.

Facilities have been reserved for the following dates: Feb. 23–27, 1964; Feb. 21–25, 1965; Feb. 20–24, 1966 and Feb. 19–23, 1967.

The New York Hilton is under construction now and is scheduled to open in January, 1963. It is located between 53rd and 54th Streets on the Avenue of the Americas. The hotel will contain over 2100 sleeping rooms, including 575 suites. The modern meeting rooms, exhibit space and dining facilities are expected to make the New York Hilton an attractive site for future TAPPI Annual Meetings.

The 1962 Annual Meeting will be held, as usual, at the Hotel Commodore on February 19–22. At that time the Association will select either the Commodore or the New York Hilton as the site for the 1963 Annual Meeting, to be held on February 17–21, 1963.

Companies wishing to reserve suites for TAPPI Annual Meetings to be held at the New York Hilton should forward their requests to Mr. Albert G. Cox, Director of Sales, New York Hilton, Suite 2214, 1270 Avenue of Americas, New York 20, N. Y. These requests will be reviewed and processed after a decision has been made on the location of the 1963 meeting.

Printing Courses

New York University's Center for the Graphic Industries and Publishing will offer a number of evening courses in printing, advertising, paperback publishing, and magazine production during the fall semester. All courses are non-degree and open to the general public. The Center is a unit of NYU's Division of General Education.

Classes will meet starting the week of Monday, September 25. Instructors are professionals drawn from business and industry.

Courses will be offered on the subjects of design and typography, pulp and paper, commercial lettering, printing inks, preparing art and copy for printing, advertising and book production, picture editing, and estimating printing.

Further information on these courses can be obtained from: Division of General Education, New York University, 1 Washington Square North, New York 3, N. Y. (telephone: SPring 7-2000, extension 8255).

*Idea submitted by Arthur Hanson, Minnesota & Ontario Paper Co., Littlefork, Minnesota

Photo by: Harold M. Lambert

The 40-mile-long Grand Teton range has 11 major **Peaks**, and is the most **Spectacular** portion of the Rocky Mountains in Wyoming.

HAM FELTZ says:

"Reminds me that HAMILTON Felts are a help to peak production, spectacular savings!"

YOU CAN'T BEAT

Hamilton

FELTS

*WIN . . . *A NEW Shakespeare Spincast Fishing Outfit!*

"What famous place reminds you of Hamilton Felts? Tell us why in a few words; sign your name and address and name of company. Each idea from a U.S. papermaker that we use wins a new 1961 model Shakespeare Spincast Rod and Reel—FREE! When identical winning ideas are submitted by 2 or more papermakers, the one with the earliest postmark will be considered the winner. Every U.S. papermaker *entrant* receives a famous Rex Spoon fishing lure — FREE. Send me your suggestion — today.
Ham Feltz, 612 First National Bank Bldg., Dept. T.
Cincinnati 2, Ohio."

"Hamilton Felts can help *you* realize peak production, spectacular savings and increased profits, because they're 'water-conditioned' — especially designed, carefully woven and porosity proven — for faster water removal, so they'll deliver drier sheets to the driers, permit operators to run machines at higher speeds . . . longer . . . turning out more tonnage, with fewer stops and less broke or imperfections.

"Ask your Hamilton Felts Service Salesman about our 300 proven styles. If one of our 'standard 300' won't solve *your* needs, we will be happy to design a Hamilton Felt that will."

SHULER & BENNINGHOFEN, HAMILTON, OHIO

TAPPI NOTES

TAPPI's Twenty-Five Year Members

As a society dedicated to advancing the industry's technology, it is quite natural that TAPPI should live in the present and plan for the future. One of the principal benefits of Association membership is the opportunities it provides to keep TAPPI members up to date on current developments and future trends.

Nevertheless it is highly appropriate that we pause occasionally to look back on what has happened in the past. In both the industry and the Association problems have a way of recurring periodically. Frequently we discover that questions confronting TAPPI today are similar to those faced many years ago. In many instances the answers then are equally valid today. At the minimum we can profit from earlier experiences by discovering how those problems were approached and by evaluating the effectiveness of their solutions.

Equally important a review of the past reminds us forcefully that we are only building today on the sound foundations provided by TAPPI members in the past. The Association's accomplishments today could never have been realized, if there had not been dedicated, energetic, and forward-looking men leading the Association in its earlier years.

As a society of volunteers it is difficult for TAPPI to recognize adequately the services and talents contributed by its members. Since 1959 Certificates of Appreciation have been granted to division, committee, and local section chairmen when they retired from office, but many other equally dedicated members have not received the recognition they undoubtedly deserved. This is particularly true of those members who were active in guiding the Association in its early years.

As a modest step in the direction of expressing TAPPI's gratitude to its senior members, the Association this month is sending hand-lettered Silver Anniversary Cards to all who have held individual memberships in the Association for 25 years or more. It is hoped that these will serve as a tangible reminder to these members that TAPPI's stature today is largely the result of their sound judgment and dedicated efforts.

Five hundred and sixty-eight of TAPPI's roughly 10,000 individual members today belonged to the Association in 1936, 25 years ago. At that time TAPPI had a total of 1354 individual members. Thus 42% of the 1936 membership still belongs to TAPPI. This is a remarkable record of loyalty and continuing service to the Association.

This select circle contains many who have held their memberships since TAPPI's earliest days. It includes thirteen who became members in 1915, the year when TAPPI was established as a section of the American Paper and Pulp Association. These charter members are:

Victor E. Fishburn
Arthur B. Green
Herbert W. Guettler
Raymond S. Hatch
A. J. Haug
C. C. Heritage
Ernst Mahler
Ralph H. McKee
George H. Mead
Clifford Patch
John D. Rue
Hervey J. Skinner
J. Newell Stephenson

At the more recent end of this 25-year spectrum are some who may be startled to qualify as "senior citizens." The years have a way of slipping by, and the receipt of a Silver Anniversary Card (like the arrival of grandchildren) may represent a welcome, though somewhat unnerving, milestone. To all of these, its faithful members, TAPPI is profoundly grateful.

To appreciate the contribution these men have made to TAPPI and to the industry it is only necessary to review TAPPI's activities 25 years ago. At that time the role of the technical man in the industry was not as widely appreciated as it is today. Many companies had not yet fully recognized the benefits of exchanging technical information or of working cooperatively on those industry-wide technical problems where cooperative effort might be fruitful.

In 1936 the Association boasted 1354 individual members and 168 company members (compared to roughly 10,000 and 520 respectively today). Over 18% of the individual members lived in 22 countries outside the United States, a proportion not strikingly different from the 25% today, although now 55 other countries are represented.

The Association's income in 1936 was derived largely from members' dues. The annual dues for an individual member then were $15, and it was not until 1959 that these were raised to the current level of $20 per year. Total expenditures for 1936 totalled roughly $39,000, which was allocated as follows: salaries and office expenses 54%, publications 29%, research 13%, and committees and local sections 4%.

An interesting sidelight is the cost of TAPPI's research efforts in 1936. A total of $2670 was allocated to support six programs. Three of these required less than $250 apiece. The research dollar obviously went farther in those days!

The Association staged two conferences a year. The Annual Meeting was held then as now in New York City each February. A fall meeting, the predecessor to today's functional conferences, was held in September or October. In 1936 Montreal was the host city.

Members received the Annual Bibliography, the Yearbook, the Standard Testing Procedures, the Technical Association Papers (an annual compilation of technical papers), and a subscription to "Paper Trade Journal," which devoted 12 pages per issue to TAPPI manuscripts.

The Association was sufficiently well-knit, so that the Yearbook could state under "Services to Members":

> "Any member may submit problems relating to pulp and paper manufacture to the secretary of the Association . . When the nature of the problem is such that no one answer will suffice, a copy of it is sent to the *entire* [italicized by editor] membership, and a transcript of the replies received is sent to all who reply and to the corporate members."

PRODUCTS and SERVICE...

OK BRAND Pregelatinized—ready to use—beater starch.

OK BRAND Cationic—effective—economical wet end additive.

OK BRAND **COZYMES** Enzyme converting starches for sizing and coating adhesives.

OK BRAND Oxidized starches—complete line for sizing and coating adhesive application.

OK BRAND **COCURE** A new line of corn starch derivatives for sizing and coating adhesive application.

OK BRAND Economical—controlled viscosity thinboiling starches for special sizing applications.

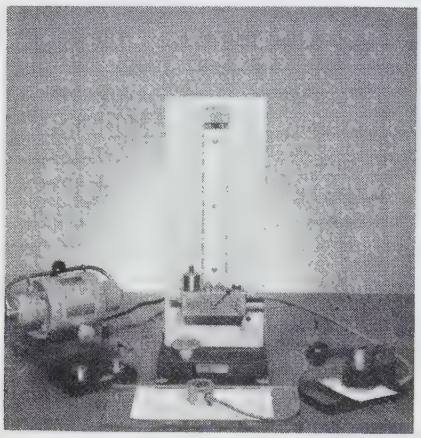
to meet your changing needs

Mistakes are costly. That's why you'll want to rely on Hubinger products and field service. For over three-quarters of a century, we've been developing, testing, and manufacturing starches and adhesives—always looking for new and better products. And, these products are serviced by trained field personnel, men who can help you solve the most complicated starch and adhesive problems. If your mill needs new starch products to meet special specifications, let our nearby Hubinger paper-starch technical service representative help you. You can depend on him—and Hubinger products—to meet your changing needs and do so economically.
Just phone or write us.

THE HUBINGER COMPANY / *Keokuk, Iowa*

New York • Chicago • Los Angeles • Boston • Charlotte • Philadelphia

THE
BENDTSEN TESTER
ONE LIGHTWEIGHT MACHINE THAT TESTS
PAPER AND PAPERBOARD
for
SMOOTHNESS . . . POROSITY . . . HARDNESS
Instantaneously



INSTANTANEOUS: No waiting—No scale adjustments.
ACCURATE: No oil or dust can enter instrument. Smoothness not effected by porosity.
VERSATILE: Completely self contained, portable, no special training required. Tests smoothness, porosity & printing hardness of paper & paperboard. Accessories available for paperboard & Hardboard.

Write for details of our 30 day free trial offer and our new time saving three tube tester

Sole Distributors
ROBBINS INSTRUMENT CO., INC.
112 West 30 St., NEW YORK 1, N. Y.

Little wonder that TAPPI became known and valued for the exchange of information it provided!

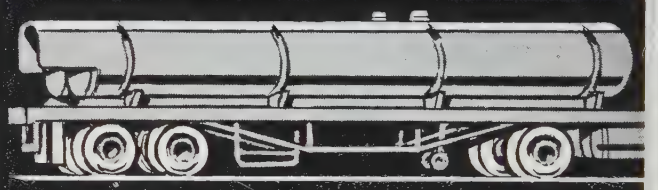
By 1936 local sections had been established in six major papermaking areas. Beginning in 1929 with the organization of the Pacific Section, other sections quickly followed in the Lake States, Delaware Valley, Kalamazoo Valley, New England, and Ohio.

TAPPI had 32 technical committees in 1936. Twelve of these are still active today. Several others have changed in name and scope to meet the new demands of our industry's technology. Others—such as the Personnel Management Committee, Patents Committee, Waste Committee, Finishing Committee, History and Biography Committee, Paper Use Requirements Committee, Permanence and Durability Committee, Color Committee, and Public Relations Committee—were subsequently disbanded when their assignments had been completed or assumed by other industry groups. Their very existence demonstrated the breadth of vision shown by TAPPI leaders 25 years ago.

At its 1965 annual meeting the Association will be celebrating its 50th anniversary. At that time TAPPI's past achievements and the men responsible for them will be widely acclaimed. We hope that most of TAPPI's older members will be on hand to receive the recognition they deserve. In the meantime the Association is awarding to all its "senior citizens" Silver Anniversary Cards in gratitude for their devoted service to TAPPI and to the industry.

PHILIP E. NETHERCUT
Executive Secretary

LIQUID
SO_2
WE ARE BASIC PRODUCERS OF SULFUR CHEMICALS



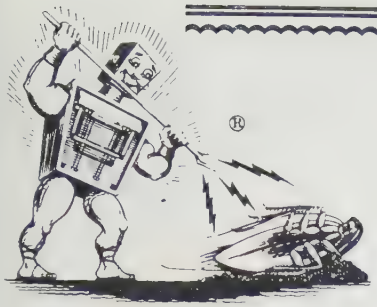
Our basic position enables us to control the PURITY of our Sulfur Dioxide from the raw materials we mine to the finished product we deliver to you.

Available in:
- Tank Cars
- Tank Trucks
- Ton Drums
- Cylinders

To the Pulp Industry we offer a dependable source of highest purity Sulfur Dioxide.

For further information Phone JAckson 3-5024 or Write.

TENNESSEE CORPORATION
612-629 Grant Building, Atlanta 3, Georgia



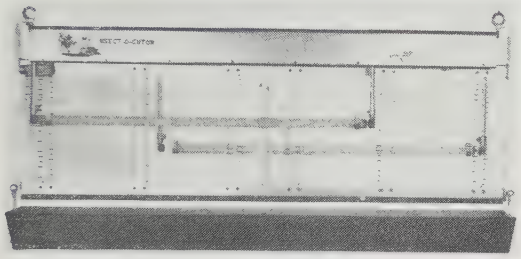
"MR. INSECT-O-CUTOR"

INDUSTRIAL
INSECT-O-CUTOR
SYSTEMS

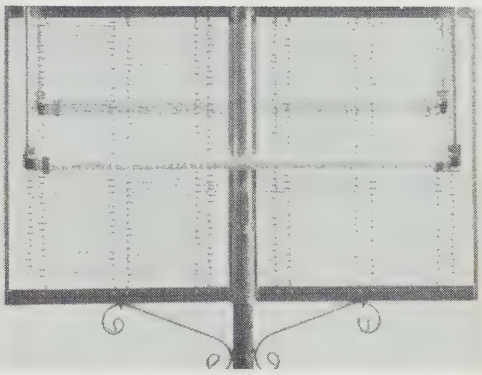
PLACE YOUR FLYING INSECT PROBLEMS IN CAPABLE HANDS
TECHNICAL SERVICE AT YOUR REQUEST

17 MODELS

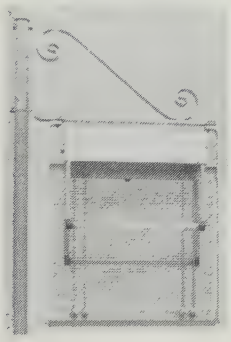
DESIGNED TO MEET
YOUR SPECIFIC
REQUIREMENTS



MODEL
AG. 560—74″ x 28″—105 LBS.



MODEL
AG. 460-30
55″ x 41″—106 LBS.



- ✓ GUARANTEED RESULTS
- ✓ 1 YEAR WARRANTY 20 YR. LIFE EXPECTANCY
- ✓ OPERATING & MAINTENANCE COST LESS THAN 1/4 OF 1% PER MO.

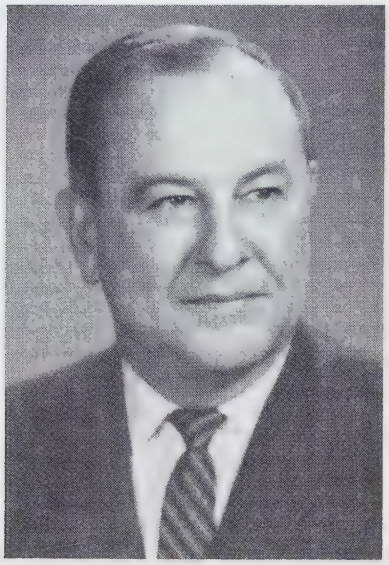
MODEL AG. 360—29″ x 25″—37 LBS.

NAMES OF USERS IN PAPER INDUSTRY AT YOUR REQUEST

GARDNER INTERNATIONAL CORP.

BOX 2717 HAMILTON STATION
POMPANO BEACH, FLORIDA
WH. 1-2310

TAPPI PROFILE



William H. Aiken

William H. Aiken, a member of the Executive Committee of the Association, is director of research and development of Union Bag-Camp Paper Corp., New York, N. Y.

Born in 1916, he grew up on a cotton farm in Salado, Tex., where he went to public school. In 1938 he received a B.S. degree in chemical engineering from Texas Agricultural and Mechanical College, graduating with both scholastic and military honors. Summer jobs included working with a surveying crew and at Humble Oil and Refining Co., Baytown, Tex.

In 1938 he obtained a scholarship to The Institute of Paper Chemistry and received a Ph.D. degree from Lawrence College in 1942. The research work for his M.S. degree, "Use of Gypsum in the Kraft Process," was carried out under the direction of Dr. Otto Kress. The research work for his Ph.D. degree, "Effect of Acetylation on Water-Binding Properties of Cellulose," was directed by Dr. Emil Heuser. Summer jobs were at Waldorf Paper Products, St. Paul, Minn., and Weyerhaeuser Timber Co., Everett, Wash.

In 1942 Bill Aiken entered the Army and was discharged in 1946 with the rank of Major. His first 18 months of service were spent in the Chemical Warfare Service Department Laboratory at M.I.T., Cambridge, Mass., working on protective coatings for paper and fabrics, and on plastic films. For the last $2^1/_2$ years of his service he was assigned to a research project at Brooklyn Polytechnic Institute, working under the direction of Dr. Herman Mark. This project was concerned with fundamental studies on synthetic rubbers and plastic materials, and on the fundamentals of water vapor transmission. In addition, there was a small development group responsible for evaluating new synthetic rubbers and plastics for Quartermaster uses.

In 1946 he joined Goodyear Tire and Rubber Co., in Akron, Ohio, as assistant manager of the plastics and coating department, which grew into the Chemical Division. He joined Gardner Board and Carton Co., in Middletown, Ohio, in 1952, as technical director. After the merger of Gardner and Diamond Match Co., to form the Diamond Gardner Corp., he became director of research of that corporation. In 1959 Aiken joined Personal Products Corp. in Milltown, N. J., as vice-president of research and development engineering, and as a director of the company. Early this year he joined Union Bag-Camp Paper Corp. as director of research and development, where he is actively planning a corporate research center to be built in New Jersey in the immediate future.

Bill Aiken became a member of TAPPI in 1941 and has been active in both national and local section affairs. He was a member of the Packaging Materials Testing Committee for many years and was its chairman from 1952 to 1954. He was one of the founding members of the Paperboard Testing Committee. From 1957 to 1959 he was chairman of the Industrial Division. In 1958 he was chairman of a committee appointed by the president of TAPPI to recommend action to improve the quality and quantity of technical manpower available to the paper industry. The recommendations of this committee led to the preparation of the brochure "What You Should Know About Career Opportunities Offered by The Pulp and Paper Industry." He was program chairman of the 1958 Testing Conference and chairman of the 1960 Testing Conference. In 1959–60 he was chairman of the Paper and Paperboard Group of the Testing Division. This February he was elected a member of the Executive Committee of TAPPI and was appointed a member of the Awards Committee.

He was active in the Ohio section of TAPPI from 1953 to 1959, serving as a member of its Executive Committee, its Program Committee, and its Academic Advisory Committee. During his term as section chairman, 1955–56, the plans for the pulp and paper course at Miami University were formulated.

Bill Aiken is also a member of the American Association for the Advancement of Science, American Chemical Society, and Sigma Xi. In the past he has either been a personal member or has represented his company on committees in the following organizations: American Forestry Association, American Society for Testing Materials, Associates, Food and Container Institute, Boxboard Research and Development Association,

When the product sticks...

make this slick...

with SYL-OFF® silicone coatings

Provide your customers with paper products that give quick, complete release from the stickiest materials —save time and money.

first in silicones

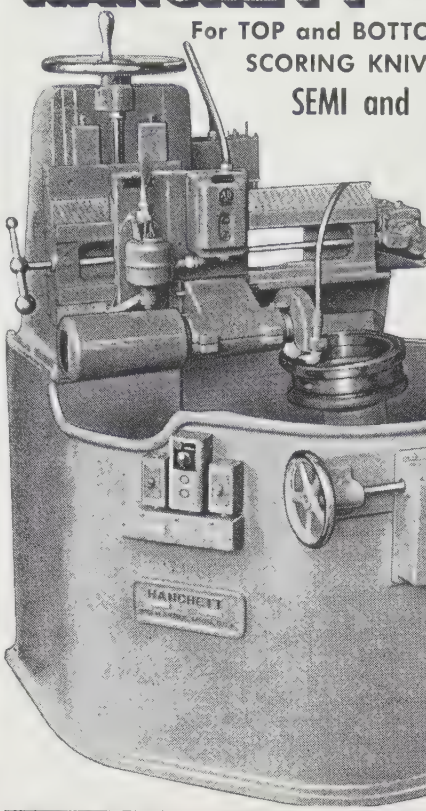
Dow Corning

For more information write Dow Corning Corporation, Department A421, Midland, Michigan

HANCHETT CIRCULAR KNIFE GRINDER

For TOP and BOTTOM SLITTER KNIVES SCORING KNIVES and SEGMENTS

SEMI and FULL Automatic



GUARANTEE:

1. Concentric with Bore and Running Truth .0005
2. Micro Inch Finishes
3. Grinds Single, Double and Compound Bevels
4. Positive — Accurate Fixturing
5. Longer Mill Life (Less Changes)

MODEL SK-24 WET GRIND

TEST GRIND

We are prepared to grind knives for your inspection and Mill Test.

HANCHETT MANUFACTURING CO.

Main Office BIG RAPIDS, MICHIGAN

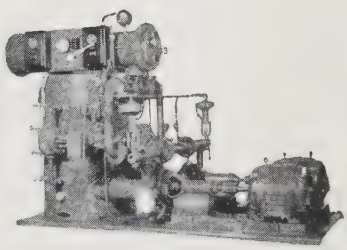
West Coast PORTLAND 1, OREGON

Folding Paper Box Association (Research Committee), Manufacturing Chemists' Association, National Paperboard Association, Biological Research Committee, The Packaging Institute, The Society of Plastic Engineers, Society of the Plastics Industry, and Technical Association of Graphic Arts.

He has been active in encouraging high school students to become more aware of science and has given many talks to students, Parent-Teacher Associations, Y.M.C.A. and service organization groups on this general subject. He was active in the North Butler County (Ohio) Science Award for a number of years and served as its chairman in 1957. He has given numerous papers before various technical organizations and has published about twenty-five papers in technical journals. Believing that education is a life long process, Bill Aiken has not only continued to further his own but has taken steps to provide needed educational facilities where these were not available. In 1947 he helped organize the Akron Polymer Lecture Group and was its chairman in 1948–49. After his company had sent him and his wife to a session of the Aspen Institute for Humanistic Studies, in Colorado, in 1956, he became interested in the activities of the Great Books Foundation. He helped organize a Great Books Discussion Group in Middletown, Ohio, and was one of its moderators for two years.

Bill Aiken lives in Princeton, N. J. His wife is the former Rosemary Polk of Belton, Tex. They have two children, Rosemary (16) and Bill (14). His hobbies include photography, reading, gardening, and camping.

The ONE Vacuum Pump Made for Paper Mills



The Stickle Vacuum Pump is made exclusively for paper mills. It's easy to service. All floats housed in exterior float boxes. Interchangeable, removable vacuum chamber is above tank. Inspection of ejector tubes may be made without moving motor, pump or piping. Uses standard horizontal motor and pump. For vacuums to 28". Built-in heat exchanger eliminates costly cooling equipment. Recirculation of hurling water condenses flash vapors and releases air and gases to atmosphere. No close clearances to cause wear. Performance guaranteed. Single and duplex models. Write for free literature.

STICKLE STEAM SPECIALTIES COMPANY

2209 Valley Ave. • Indianapolis 18, Ind.

Moisture Control Systems
Dryer Drainage Systems
Feed Water Heaters
Vacuum Pumps
Micro Adjustable Orifices
Differential Control Valves

PERSONAL MENTION

New TAPPI Members

Howard L. Averbach, Supervisor, Paper Testing Laboratory, United States Testing Co., Inc., Hoboken, N. J., a 1951 graduate of Lowell Technological Institute.

Jerome V. Bennett, Manager, Budgets and Standards, Riegel Paper Corp., Milford, N. J., a 1951 graduate of Georgia Institute of Technology.

George E. Brown, Jr., Technical Director, Amberley Co., Cincinnati, Ohio. Attended the University of Cincinnati.

Norman M. Cassie, Research Manager, Standard Insulation Co., East Rutherford, N. J., a 1950 graduate of Upsala College.

Linwood G. Collins, Jr., Laboratory Foreman, Container Corp. of America, Brewton, Ala. Attended the University of Georgia.

Daniel G. Crosse, Head, Science Dept., Technical College, Bury, Lancashire, England. A graduate of Glasgow University.

Warren B. Dannenberg, Associate Project Engineer, Chas. T. Main, Inc., Boston, Mass., a 1936 graduate of Massachusetts Institute of Technology.

Jean X. Desforges, Process Engineer, Singmaster & Breyer, New York, N. Y., a 1942 graduate of the University of Paris, School of Forestry.

Eugene Doven, Vice-President, Appleton Machine Co., Appleton, Wis., a 1934 graduate of Crane College.

George K. Eliades, Wood Technologist, Bowater Board Co., Catawba, S. C., a 1960 graduate of North Carolina State College.

Harry S. Fisher, Assistant Manager, Technical Service Dept., Pennsalt Chemicals Corp., Tacoma, Wash., a 1934 graduate of the University of Washington.

Vernon T. Francis, Senior Project Engineer, Minnesota & Ontario Paper Co., International Falls, Minn., a 1946 graduate of the University of Washington.

Keizo Fujisaki, Chief, Technical Section, Japan Wire Cloth Co., Ltd., Tokyo, Japan. Attended Tokyo Agricultural & Technological College.

Mario Gambioli, Director, Graphic Laboratory, Ente Nazionale per la Cellulosa e per la Carta, Rome, Italy, a 1926 graduate of Rome University with a D.Chem. degree.

Frederick A. Gill, Sales Engineer, Frank W. Egan & Co., Somerville, N. J., a 1951 graduate of Hunter College.

Marcel C. Gilot, Technician, S.A. Glucoseries Reunies, Alost, Belgium.

Charles A. Godsell, Eastern Regional Manager, Shawinigan Resins Corp., New York, N. Y., a 1942 graduate of Hamilton College.

Carlos Holz Gomez, Managing Director, Silicatos Solubles de Mexico, S.A., Mexico, D.F.

Harold R. Harlan, President, Paint Research Laboratory of Harlan Associates, San Francisco, Calif. Attended University of Missouri.

Robert H. Hart, Staff Engineer, Beloit Iron Works, Beloit, Wis., a 1949 graduate of Georgia Institute of Technology.

Lennart Hedborg, Technical Director, Union Allumettiere S.A., Brussells, Belgium.

W. Robert Holt, Quality Superintendent, Nicolet Industries, Inc., Norristown, Pa., a 1957 graduate of the University of Toronto.

James A. Huber, Engineer, The Cleveland Container Co., Cleveland, Ohio, a 1950 graduate of Case Institute of Technology.

Malcolm J. Jennings, Works Chemist, Taylowe Ltd., Maidenhead, Berkshire, England. Attended Brunel College.

Robert K. Johnson, Director of Quality Control, Hilton-Davis Chemical Co., Cincinnati, Ohio, a 1949 graduate of Ohio State University.

Victor T. Johnson, Divisional Sales Manager, Cameron Machine Co., Dover, N. J. Attended Brooklyn Polytechnic Institute.

Harold J. Kandiner, Manager of Quality Control, Barrett, Div., Allied Chemical Corp., New York, N. Y., a 1938 graduate of Cooper Union Institute of Technology.

Mats Kassberg, Pulp Mill Superintendent, Korsnos A/B, Gavle, Sweden, a 1950 graduate of Chalmers University of Technology.

Kurt Kraft, Board Member, Carl Freudenberg Co., Weinheim-Bergstrasse, Germany, a 1932 graduate of Heidelberg University, with a D.Chem. degree.

Hector Lagos, President, Maquinaria International S.A., Mexico, D.F.

Benjamin H. Landis, Head, Industrial Applications Section, Technical Sales Service, Clinton Corn Processing Co., Clinton, Iowa, a 1950 graduate of Kansas State University.

Austin B. Le Strange, Jr., President, Austin LeStrange Co., Inc., New York, N. Y., a 1949 graduate of Columbia University.

Giuseppe Lunardi, Sales Manager, Verrina S.p.A., Genoa, Italy, a graduate of the University of Genoa with a D.Eng. degree.

James Mair, Chemist, Thomas Hedley & Co., Ltd., Newcastle-on-Tyne, Northumberland, England, a 1945 graduate of Glasgow University.

Wieslaw D. Markowski, Winder Sales Manager, Beloit Eastern Corp., Downingtown, Pa., a 1948 graduate of South-West Essex Technical College, London, England.

Walter D. McVicar, New Products Manager, Fine Papers Div., West Virginia Pulp & Paper Co., New York, N. Y., a 1947 graduate of Columbia School of Engineering.

Cleo E. Mikel, District Manager, Corn Products Sales Co., Buffalo, N. Y.

William E. Montgomery, Jr., Engineer, Finch, Pruyn & Co., Inc., Glens Falls, N. Y., a 1952 graduate of Michigan State University.

W. R. Moss, Information Officer, Petrochemicals, Corrington Research Laboratory, Urmston, Manchester, England.

George L. Nelson, Development Director, Bird Machine Co., South Walpole, Mass., a 1943 graduate of Massachusetts Institute of Technology.

Joseph J. Nelson, Jr., Sales Manager, Calcium Products Div., The Georgia Marble Co., Tate, Ga. Attended Davidson College.

Guglielmo Pepi, General Manager, Verrina S.p.A., Genoa, Italy, a graduate of the University of Pisa with a D.Eng. degree.

Norman H. Plotkin, Staff Technologist, Shell Chemical Co., New York, N. Y., a 1953 graduate of the University of Illinois.

Alick L. Poole, Director General of Forests, New Zealand

Forest Service, Wellington, N. Z., a 1931 graduate of Auckland and Victoria College.

Rusi P. Pudumjee, Managing Agent, Production and Technology, Pudumjee Paper Mills Private Ltd., Bombay, India, a 1945 graduate of Victoria Jubilee College.

Gerald E. Quinn, Chief Chemist, The Carter Ink Co., Cambridge, Mass., a 1941 graduate of Sienna College.

William J. Rapoport, Manager, Sales Development, Paper Chemicals Dept., American Cyanamid Co., New York, N. Y., a 1946 graduate of Massachusetts Institute of Technology.

Thomas E. Redstone, Product Planning Manager, Dexter & Lawson Div., Miehle-Goss-Dexter, Inc., Pearl River, N. Y., a 1943 graduate of Dartmouth College.

Gustav V. Rosenqvist, Assistant Resident Manager, Kymmene A/B, Kuusankoski, Finland, a 1948 graduate of Abo Akademi.

Norman H. Russo, Technical Sales Representative, National Aniline Div., Allied Chemical Corp., Chicago, Ill. Attended Pratt Institute of Technology, Brooklyn.

Arcadio C. Santos, Jr., Technical Consultant, ABCO Pulp & Paper Co., Manila, Pa., a 1952 graduate of LaSalle College.

Ugo M. Schilke, Production Manager, Chatillon S.p.A., Milano, Italy, a 1935 graduate of the University of Pavia with a Ph.D. degree.

Lennart Schotte, Mill Manager, Amotfors Pappersbruks A/B, Amotfors, Sweden, a 1956 graduate of the University of Uppsala with a D.Sc. degree.

David O. Sebastian, Assistant Technical Superintendent, St. Regis Paper Co., Jacksonville, Fla., a 1949 graduate of the University of Chattanooga.

Jules Sherman, Research Director, Walter Drey Associates, New York, N. Y., a 1946 graduate of City College.

Michael I. Sherman, Chemical Engineer, Kamyr, Inc., Hudson Falls, N. Y., a 1953 graduate of McGill University.

Lam Van Si, Administrative Manager, Cong-Ty Giay Va Hoa-Pham Dong-Nai, Saigon, Vietnam, Indochina.

Rex S. Smith, Senior Technical Service Representative, Jefferson Chemical Co., Austin, Texas. Attended Park College.

Charles M. Thompson, General Manager, General Printing Ink Div., Sun Chemical Co., New York, N. Y. Attended Fordham University.

Adrian H. van der Marel, Technical Adviser, Neypro N.V., Zaandam, Holland. Attended the Chemical-Technical College.

Walter D. Watt, Plant Engineer, Weyerhaeuser Co., Grays Harbor Branch, Cosmopolis, Wash., a 1949 graduate of McGill University.

Gerald W. Wiggins, Partner, Manufacturers' Agent, Birmingham, Ala., a 1949 graduate of the University of Alabama.

George Ham Wong, Staff Engineer, Peloit Eastern Corp., Downingtown, Pa., a 1952 graduate of the University of Wisconsin.

B. Montgomery Wood, Manager, Market Research Department, Howard Smith Paper Mills, Ltd., Toronto, Ont., Canada, a 1930 graduate of the University of British Columbia.

Robert L. Wright, Development Engineer, West Virginia Pulp & Paper Co., Wellsburg, W. Va., a 1948 graduate of the University of Florida.

Appointments

Michael Alsimaani, formerly of the Iraqui Army, is now Director General of Industrial Design and Construction for Republic of Iraq, Baghdad, Iraq.

Donald W. Bail is now Assistant Pulp Mill Superintendent for Great Northern Paper Co., Millinocket, Me.

Lothrop Bartlett, formerly of Madison Mills, is now Production Manager of St. Croix Paper Co., Woodland, Me.

Howard B. Berrong, of Socony Mobil Oil Co., has been transferred from St. Paul, Minn. to New York, N. Y., as Senior Staff Engineer, in the Chemical Products Division.

Charles H. Borchers, formerly of the Lithographic Technical Foundation, is now Plant Superintendent for R. M. Rigby Printing Co., Kansas City, Mo.

Robert E. Brouillard is now Vice-President and Director of Marketing for the paper and textile industry of Penick & Ford Ltd., Inc., New York, N. Y.

Edmond W. Carney, of West Virginia Pulp & Paper Co., Hinde & Dauch Division, has been transferred from Sandusky, Ohio to Torrance, Calif.

George H. Carson has retired as Vice-President of Bowaters Southern Paper Corp., Calhoun, Tenn.

Charles H. Claypool, formerly of Oxford Miami Paper Co., is now Mill Manager of Nova Scotia Pulp, Ltd., Port Hawkesbury, N. S.

Cecil H. Clinton, formerly of Pennsylvania Industrial Chemical Corp., is now a Technical Service Representative for Heyden-Newport Chemical Co., Pensacola, Fla.

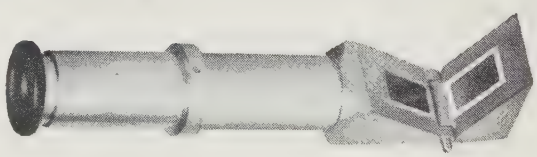
Marcus H. Davis, formerly of Allied Chemical Corp., is now Paper Chemicals Product Manager for Virginia Chemicals & Smelting Co., W. Norfolk, Va.

Richard H. Dillinger is now Manager of Starch Sales for Morningstar-Paisley, Inc., New York, N. Y.

Russell K. Elston is now Technical Superintendent of the Nekoosa-Edwards Paper Co., Potsdam, N. Y.

. . . for Starch, Sizings and other Solutions

POCKET REFRACTOMETER



. . . other types available: Abbe, Pulfrich, Immersion, and Projection.

$99.00 fob. N. Y.

Available in 5 ranges: soluble solids — 0–28%, 0–50%, 15–55%, and 40–85%; starch — 0–27%.

Also available calibrated in RI.

EPIC, Inc. 150 Nassau Street, New York 38, N. Y. Digby 9-2470

Sales Agents Invited

Aarno J. Esila, formerly of Metex Corp., is now with Kemijarvi Oy, Helsinki, Finland.

Donald M. Ferguson, of St. Regis Paper Co., has been transferred from Carthage, N. Y. to New York, N. Y., as Acting Director of Technical Service and Control.

W. F. Gillespie is now Assistant Vice-President of Crown-Zellerbach Corp., Bogalusa, La.

Ivan Guskov, Research Engineer of Continental Can Co., has been transferred from Mt. Vernon, Ohio to Chicago, Ill.

William D. Hall has retired as Research Director of the Folding Paper Box Association, Chicago, Ill.

Clark R. Hayner, formerly of Champion Paper & Fiber Co., is now Senior Research Engineer for Continental Can Co., Chicago, Ill.

Harold R. Hickson, Senior Chemical Engineer for Continental Can Co., has been transferred from Uncasville, Conn. to Augusta, Ga.

George W. Holmes, formerly of Oregon State College, is now a Research Chemist for Dow Chemical Co., Pittsburg, Calif.

Robert M. Husband, formerly of Consolidated Paper Corp., Ltd., is now Manager of Central Research for Riegel Paper Corp., Milford, N. J.

Burleigh M. Hutchins, formerly of Rust Engineering Co., is now Vice-President in Charge of Engineering for Bird & Son, Inc., E. Walpole, Mass.

Walter C. Jacoby of Crown Zellerbach Corp., has been transferred from Camas, Wash. to San Francisco, Calif. as Specialty Papers Product Manager.

Harland D. Jurgensen, formerly of North Carolina Pulp Co., is now with Fibreboard Paper Products Corp., Antioch, Calif.

Burt L. Kassing, Resident Manager of Nekoosa Edwards Paper Co., has been transferred from Potsdam, N. Y. to Port Edwards, Wis.

Elton T. Krogel is now Pulp Mill Superintendent of Rhinelander Paper Co., Div. of St. Regis Paper Co., Rhinelander, Wis.

Robert A. Larson, formerly of Allied Paper Corp., is now Technical Assistant to the Vice-President of Brown Co., Berlin, N. H.

Fred P. Lodzinski, formerly Student at The Institute of Paper Chemistry, is now a Research Chemist for Nekoosa-Edwards Paper Co., Port Edwards, Wis.

Edward H. Lougheed, Mill Manager of Abitibi Power & Paper Co., Ltd., has been transferred from Sault Ste. Marie, Ont. to Toronto, Canada.

Manfred Luthgens, formerly of Nalco Chemical Co., is now Manager of the Pulping Division of Lurgi Gesellschaft fur Chemie und Huttenwesen, Frankfurt, Germany.

Stanley F. M. Maclaren is now Eastern Sales Manager for Penick & Ford Ltd., Inc., New York, N. Y.

Robert M. Mayer, formerly of Champion Paper & Fibre Co., is now a Technical Sales Representative for Rayonier, Inc., New York, N. Y.

George Morley, formerly of Champion Paper & Fibre Co., is now a senior engineer with Great Northern Paper Co., Millinocket, Me.

John G. Morrison, of the Abitibi Power & Paper Co., has been transferred from Toronto, Ont. to Sault Ste. Marie, Ont. as Mill Manager.

Wendell W. Moyer, formerly of Crown Zellerbach Corp., is now a Consultant at 6902 N. E. Tillamook St., Portland, Ore.

Raoul L. Naville, formerly of Papierfabrik Gemrigheim, is now General Manager of Cham Paper Mill, Cham, Switzerland.

Teuvo Niensioja, formerly of Instrumentarium Oy, is now with Jerak Oy, Helsinki, Finland.

Robert T. Olsen, formerly of Standard Register Co., is now President and General Manager of Chemed, Inc., Odenton, Md.

Joseph A. Paciello, formerly of E. I. du Pont de Nemours & Co., is now Manager of the Paper and Leather Division of Berkshire Color & Chemical Co., Reading, Pa.

Cornelius F. Reardon, Jr., formerly of Mystick Adhesive Products, Inc., is now Senior Chemist for American Photocopy Equipment Co., Evanston, Ill.

Leonard B. Schlosser, formerly of Schlosser Paper Co., is now Executive Vice-President of Lindemeyr-Schlosser Co., Long Island City, N. Y.

R. Lawrence Scoville, Research Chemist of Continental Can Co., has been transferred from Uncasville, Conn. to Augusta, Ga.

Leslie S. Simser is now Western Sales Manager of Penick & Ford Ltd., Inc., Cedar Rapids, Iowa.

Horace L. Smith, Jr. is now with the Southern Division of Hupp Corp., Richmond, Va.

Seth M. Snyder of Babcock & Wilcox Co., has been transferred from Charlotte, N. C. to Pittsburgh, Pa. as District Sales Manager.

Carl H. Swartz, formerly of Beloit Iron Works, is now Sales Manager for Beloit International Corp., Zurich Switzerland.

Joseph F. Theriault, Chemist for Continental Can Co., has been transferred from Chicago, Ill. to Haverhill, Mass.

Anthony E. Thiesen is now President of Chemipulp Process, Inc., Watertown, N. Y.

Joel W. Thompson, of Babcock & Wilcox Co., has been transferred from Cincinnati, Ohio to Charlotte, N. C.

Ralph A. Traill, formerly of Portals, Ltd., is now Manager of Devon Valley Mill of Wiggins, Teape Paper Mills, Ltd., Exeter, Devon, England.

Martin J. Troster, of Union Bag-Camp Paper Corp., has been transferred from Savannah, Ga. to Franklin Va. as a group leader.

Curtis S. Walseth, of Weyerhaeuser Co., has been transferred from Cosmopolis, Wash. to Everett, Wash.

George E. Weinman has retired as Plant Engineer of Bloomer Bros. Co., Newark, N. J.

Baxter L. Willey, formerly of West Virginia Pulp & Paper Co., is now in the Research and Development Department of Penick & Food Ltd., Inc., Cedar Rapids, Iowa.

Virgil O. Wodicka, formerly of the Quartermaster Food & Container Institute, is now Technical Director of Hunt Foods & Industries, Fullerton, Calif.

Clyde D. Woodburn, of Corn Products Sales Co., has been transferred from New York, N. Y. to Philadelphia, Pa. as District Manager.

Phillip M. Ziegler, formerly engineer of St. Joe Paper Co., is now with Olin Mathieson Chemical Co., Forest Products Div., W. Monroe, La.

* * *

Antoni Rocheleau, Chief Application Engineer for the paper industry has succeeded **David A. Bossen** as the official representative of Industrial Nucleonics Corp., Columbus, Ohio in the Technical Association.

Erik Goranson, President, has succeeded **N. R. Johanneson** as the official representative of Cellulose Sales Co., New York, in TAPPI.

Carl G. Smith has succeeded **A. B. Adams** as the official representative of Goslin-Birmingham Co., Inc., Birmingham, Ala., in TAPPI.

J. J. Waddock, Vice-President in Charge of Sales has succeeded **K. S. Ducayet, Jr.,** as the official representative of the Clark-Aiken Co., Lee, Mass., in the Technical Association.

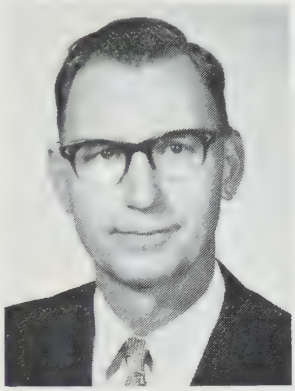
INDUSTRY NOTES

Paper Manufacturers and Converters

BOWATERS CAROLINA CORP.

Homer L. Lusby has been named paper machine superintendent and **Hubert M. Lyle** has been named coating superintendent for Bowaters Carolina Corp., Catawba, S. C.

Homer L. Lusby, Bowaters Carolina Corp.



Hubert M. Lyle, Bonatios Carolina Corp.

BOWATERS SOUTHERN PAPER CORP.

George H. Carson of Athens, an executive in the Bowater organization in North America for 23 years, has retired as vice-president and a director of Bowaters Engineering and Development, Inc.

BROWN CO.

Donald H. Welch, of Birmingham, Ala., has become manager of operations of Brown Co.'s new Bermico fiber pipe and conduit plant in Birmingham.

Robert A. Larson, formerly development manager for Allied Paper Co. at Kalamazoo, Mich., has joined Brown Co. as technical assistant to the vice-president and general manager of the Paper Division, Edward H. Petrick. In this capacity, he will be responsible for grade development, process and quality control, and technical service to the Paper Division, and will report directly to Mr. Petrick.

BUCKEYE CELLULOSE CORP.

Interface Detection in High Density Bleach Towers

The temperature differential method of detecting the interface in high density stages of wood pulp bleaching has been successfully adapted by Buckeye Cellulose Corp. to a situation in which little or no temperature differential exists under normal operating conditions.

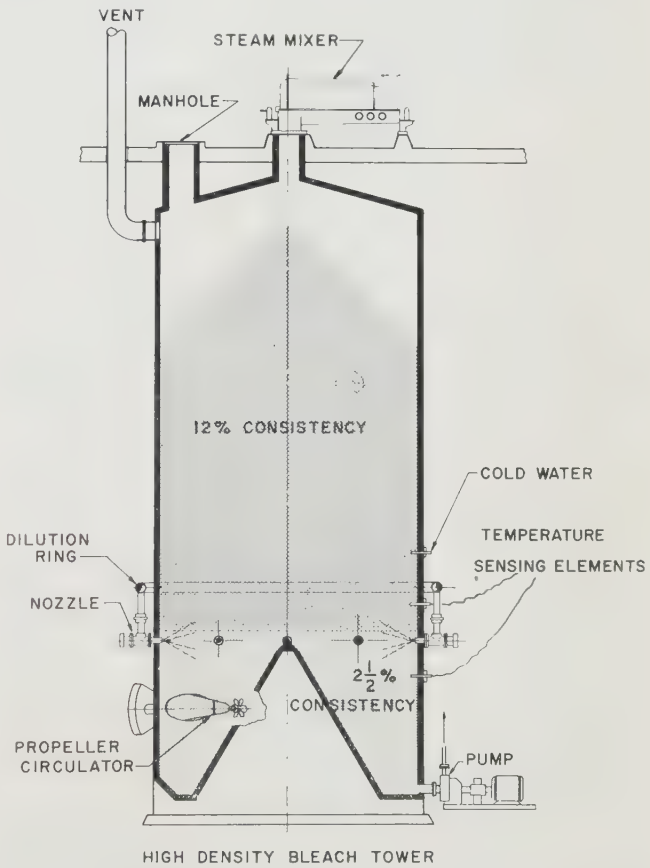
The new method, presently in operation on three bleach stages at Buckeye's Foley, Fla., wood pulp mill, has proved inexpensive to install and maintain and extremely satisfactory in performance.

In the high density stages of modern continuous wood pulp bleaching, bleaching chemicals and steam are added to pulp in a mixer, from which the pulp drops into the top of a retention tower. Consistencies of 10 to 15% are generally maintained at this point. Pulp is removed from the bottom of the tower by injecting water to dilute it to about 3%, agitating it and then pumping it out.

When this equipment is properly designed and operating correctly, there is a sharp division, or interface, between the dilute pulp in the bottom and the high density pulp above. The movement of this interface must be kept within a narrow range in order to maintain adequate retention, insure uniform operation and prevent plugging of the discharge pipe. Detection of the position of the interface is therefore of extreme importance.

The normal method of interface detection is by temperature differential, since high density and dilute stock are seldom at the same temperature. Two thermometer bulbs are installed in the tower, one just above and the other just below the desired interface level. As the interface rises, the upper thermometer reading approaches that of the lower one and corrective action can be taken. Similarly, a descending interface will cause the lower thermometer to register a temperature approaching that of the upper one.

This standard temperature differential method had been used at the Foley wood pulp mill since the beginning of operations. A new detection method had to be found, however, when a second mill and a parallel bleaching system were installed as part of a plant expansion program. To achieve best operating conditions in the new system and provide most economical use of steam, hot water from waste heat was made available for washing after passing through several hot, high density towers. As a result, the temperature of the dilution, or mining, water approached



Adaptation of standard interface detection method as employed at Buckeye Cellulose Corp.'s Foley, Fla., wood pulp mill

that of the pulp in the tower, thus preventing satisfactory use of the standard interface detection method.

After trials of several alternate systems, it was found that the temperature differential method could be made to work by injecting a small stream of cool water just above the top thermometer. Ten to 15 g.p.m. of cool water was found to cool a small portion of high density downward flowing pulp, registering a cooler temperature on the upper thermometer, while the lower one remained hot from the well agitated low-consistency slurry below the interface. As the interface drops, the cooling reaches the lower thermometer; and as it rises, the dilution water heats the upper thermometer.

This simple and inexpensive system has worked well, with no maintenance problems, since shortly after the start of the expanded bleaching operation. While the exact mechanism of the cooling is not known (injected water may cool the high density pulp, the tower wall or a combination of the two), the results have been consistently satisfactory.

Buckeye engineers believe the method would be practical for interface detection in cool high density pulp storage systems also, with injection of hot rather than cool water above the thermometers.

Architect's sketch of the new Continental Can Company building, 633 Third Avenue, New York City

Continental Can Co.

Continental Can Co. will consolidate its head office staff and all of its other New York City offices in a new building at 633 Third Ave. in late August and early September of this year. Certain of the company's division offices from outside of New York will also relocate in 15 floors of the 41-story building between 40th and 41st Sts. in New York.

Moving over with the Robert Gair Paper Products Group staff are the headquarters of the Paperboard and Kraft Paper Division, Bondware Division, Folding Carton and Drum Division, and Corrugated Container Division.

Crown Zellerbach Corp.

Bogalusa

Crown Zellerbach Corp. is undertaking an $8.2 million modernization and diversification program in its Bogalusa, La., pulp and paper mill. Preliminary engineering work has been started on the replacement of the mill's no. 2 cylinder paper machine with a new, highly efficient and versatile all-purpose specialty machine which will produce a variety of bleached kraft paper specialty grades. It is expected that this machine will be in operation in the next 18 months. The new machine, designed to produce a 120-in. trim sheet, will have a daily capacity of from 95 to 100 tons, and will produce paper at a maximum rate of 1200 f.p.m. Paper will be produced on the machine in various basis weights ranging from 30 to 150 lb.

The stock preparation system for the new machine will be completely modern and will include new centrifugal cleaners and pressure screens.

Another vital part of this installation will be the necessary storage systems to provide the various types of pulps required for the specialty papers. Furthermore, the necessary related changes and additions will be made in the pulp mill to support this program.

W. F. Gillespie, resident manager of Crown Zellerbach Corp.'s Bogalusa, La., division, has been promoted to the position of assistant vice-president of the corporation, it was announced today. This is in recognition of the major contributions that Mr. Gillespie has made over his many years of association with the company, both to the division he has been directing and to the Bogalusa community as a whole. Mr. Gillespie will continue to maintain his office in Bogalusa.

C. R. Dahl, resident manager of the St. Francisville, La., printing paper mill, has been named resident manager of the company's mill division at Bogalusa, replacing Mr. Gillespie. Succeeding Mr. Dahl as the new resident manager at St. Francisville will be **William E. Parkinson,** who has been assistant resident manager of the mill since February, 1960. The St. Francisville mill is owned jointly by Crown Zellerbach and Time, Inc., and is under Crown Zellerbach management.

Antioch

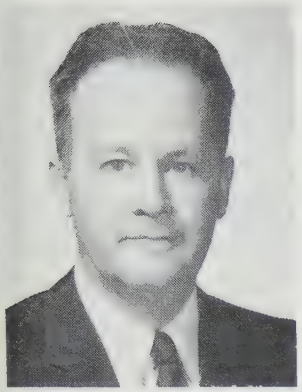
William H. Maxwell, product manager for bags and bag papers in Crown Zellerbach Corp.'s San Francisco headquarters, has been named an assistant resident manager of the firm's Antioch, Calif., paper mill division effective on August 1.

Replacing Mr. Maxwell at headquarters as product manager for bags and bag papers will be **Arthur W. Wetmore,** who has been serving as superintendent of the multiwall bag department at Antioch. Succeeding Mr. Wetmore as the new Antioch multiwall superintendent will be **Bertram L. Steinberg,** currently multiwall shift foreman at Antioch.

Georgia-Pacific

Wood Chemicals

Allied Chemical Corp. will jointly explore with Georgia-



Robert J. Van Nostrand, Merrimac Paper Co.

Pacific the feasibility of developing commercially certain Georgia-Pacific patented processes for manufacturing chemicals from wood. The processes, which are in the fields of cellulose and lignin chemistry, resulted from a three-year study by Georgia-Pacific. A pilot plant at Portland, Ore., has been producing a variety of chemical products from bark and wood fiber usually considered waste.

INTERNATIONAL PAPER CO.

Container Division

International Paper Co.'s Container Division announced that it intends to break ground within a month on a new plant for the manufacture of corrugated shipping containers in the Pittsburgh, Pa., area. The 118,000-sq. ft. structure will be built on a 20-acre tract near the New Stanton interchange of the Pennsylvania Turnpike on new Route 71. The plant also will be served by the Pennsylvania Railroad.

Staff

Erling Riis one of the pioneers of the southern pulp and paper industry has retired as general manager of the Southern Kraft Div. of International Paper Co.

Arthur L. Ross, for 35 years an associate of Mr. Riis, and assistant general manager of the company's southern operations since 1952, has been named general manager and **C. L. Crain,** also a veteran of more than 35 years with the company, has been promoted to assistant general manager.

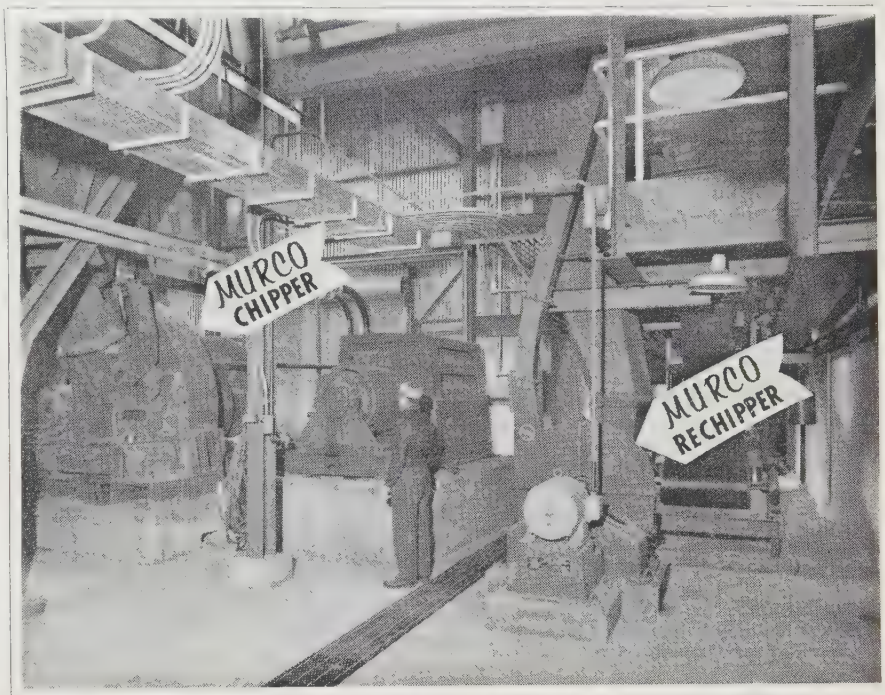
Assignment of new responsibilities to two senior executives of the International Paper Co. was announced by Richard C. Doane, chairman. Mr. Doane said that **George T. Ward,** a vice-president of the company since 1958, has been designated vice-president in charge of manufacturing for the company's pulp, paper, and paperboard operations in the United States. **Leonard Dalsemer,** vice-president of International Paper and chairman of its subsidiary, the Lord Baltimore Press, will move his headquarters to the company's executive offices, where he will assume special administrative duties within the company.

MERRIMAC PAPER CO., INC.

Robert J. Van Nostrand has been named president of Merrimac Paper Co., Inc., one of the country's oldest manufacturers of kraft papers. Formerly associated with Brown Co., Berlin, N. H., Dr. Van Nostrand has a broad administrative, marketing and technical background in the pulp and paper industry. Graduating with honors from Lawrence College in 1939, he received his M.A. and Ph.D. in pulp and paper technology at The Institute of Paper Chemistry, Appleton, Wis.

MOSINEE PAPER MILLS CO.

Mosinee Paper Mills Co. is helping teachers in the Mosinee, Wis., public schools to advance themselves in the field of education and to provide better education for the students. Grants totalling $1500 were made this year



QUALITY CHIP PRODUCTION

...with MURCO Chipper and Rechipper in Weston Paper & Pulp Mfg. Co.

To meet their requirements for quality chip production in their simplified system for handling wood Weston Paper & Pulp Manufacturing Co. at its Terre Haute plant selected MURCO Pulpwood Chipper and Rechipper (described in detail in the panel at the right).

The MURCO Chipper, like all MURCO Pulpwood Chippers, is designed to include the desirable features for today's production requirements...backed by years of constant development and the incorporation of various features that contribute to outstanding chipper performance to produce more and better chips with less sawdust, fewer slivers and freedom from repairs.

MURCO Rechipper is a real money saving equipment for mill operators looking for quality in chip production . . . as in the Weston Paper & Pulp Manufacturing Company installation, maximum quality chip production results.

MURCO Chipper

Illustrated above is the MURCO 90" 10-knife Chipper, with a chip production capacity of 25 to 35 cords an hour of ⅝" chips . . . operates at 400 rpm with V-belt drive 500 hp, 720 rpm motor. The chipper has a blower housing for blowing chips to a cyclone . . . 19" diameter spout with a pneumatically operated, linked cover for raising to release oversize logs or jams. A disc brake assembly stops the chipper when power is cut off, when discharge line may be plugged by logs.

MURCO Rechipper

Illustrated is the MURCO 40" 6-knife Rechipper, to reclaim oversize rejects . . . driven by a 15 hp, 900 rpm direct connected motor. Discharged chips are blown to the cyclone for rescreening . . . accepted chips discharge onto a belt conveyor and transferred to chip storage silo.

WRITE for complete story on MURCO Pulpwood Chippers and MURCO Rechippers.

MURCO TRADE MARK REG. U.S. PAT. OFF.

D. J. MURRAY MANUFACTURING CO.

Manufacturers Since 1883 WAUSAU, WISCONSIN

through Mosinee Paper Mills Foundation, Inc., a non-profit organization.

The purpose of the summer academic improvement program is to grant assistance to those teachers who, during the summer, enroll at a recognized institution of higher learning to increase their academic proficiency or improve their teaching skills. The individual awards are apportioned so that greater incentive is provided to teachers taking course work which, in the opinion of the awarding committee, best meets the current needs of the Mosinee public school system.

A limit has been set on the amount awarded to any one individual. The amount of each award is determined by a committee consisting of the superintendent of Mosinee public schools, the president of the board of education, and an employee of Mosinee Paper Mills Co.

Nekoosa-Edwards Paper Co.

Potsdam Mill

Promotions affecting four men in the Potsdam, N. Y., mill of Nekoosa-Edwards Paper Co., a leading producer of writing and printing papers, were announced. The changes, effective August 1, resulted from the company's recent placing the Potsdam sulfite mill on a stand-by basis.

John O'Brien was named mill manager. He will be responsible for overall operation of the Potsdam mill and will report to **C. M. Sigvardt,** Port Edwards, manager of manufacturing operations.

Russell Elston becomes technical superintendent, responsible for the technical department, maintenance, power, electrical and general yard operations. He will report to O'Brien. **George McLennan** was named office manager, responsible for purchasing, general services and industrial relations. **Michael Fetcie** was named supervisor of accounting and order processing and in addition, will be responsible for costs and traffic. **Burt L. Kassing,** who has been resident manager since 1957, and **L. J. Berryman,** general services manager since 1957, will return to Port Edwards for staff assignments.

Packaging Corp. of America

Plans for a million dollar addition to the facilities of Packaging Corp. of America's modern bleached kraft mill in Filer City, Mich., were announced. Construction of the building is now underway and completion is scheduled for early fall. The current improvements include an 81,500 sq. ft. building to expand bleached kraft finishing room and provide additional warehouse space, a heat recovery system, and additional finishing equipment.

The paperboard machine revisions will permit important improvements in finishes and coatings to provide better printing surfaces for bleached kraft and blended paperboards used in quality packaging of foods, pharmaceuticals, and numerous other products.

Potlatch Forests, Inc.

The first continuous Impco vertical digester to be installed for production of kraft pulp is planned for Potlatch Forests, Inc., at Lewiston, Idaho, with a capacity of 330 air-dry tons a day.

The vertical cooking installation utilizes the Impco chip lifter and the Skew-Jector. The chip lifter is a machine for moving chips upward through the digester, while the Skew-Jector is a high-pressure feeder to handle both chips and cooking liquor without damage to the wood fibers.

Chips and liquor from the Skew-Jector are fed into the chip lifter, which advances chips slowly up as a compact mass. The liquor moves independently and overflows through a strainer at the top after which it is sent to the recovery plant. Cooked chips are removed from the top by a scraper to the blow tank. The pulp is delivered to the bleach plant without bleach plant modification, except that this continuous pulp process has eliminated the need for one stage of brown stock washing.

A feature of this design is the near-perfect thermal stability. This feature is expected to permit close control over the end product.

Another feature, from a community standpoint, is that pulp discharge is more easily and closely controlled, which will aid in the abatement of odor and discharge of non-condensable gases.

Rayonier Canada, Ltd.

Woodfibre Mill Conversion

The Woodfibre mill produced unbleached sulfite pulp during its earlier days, that is from 1912 to 1938. In the latter year a bleach plant was added and thereafter the primary product was dissolving grade bleached sulfite pulp.

The 1961 conversion program entailed abandonment of such existing equipment as was suitable only for production of sulfite pulp and the installation of facilities for producing bleached kraft.

Space is limited at Woodfibre as the site is on a relatively small, more or less level area, bounded by water on one side and by steep slopes on the other sides. Accordingly, careful planning was required to make effective use of the available ground area and of existing buildings but at the same time to provide a sound, practical arrangement of equipment. This planning too had to allow for not only the initial production of 250 tons of pulp daily but for increasing the production to twice this amount at a later date.

Demolition of obsolete buildings and equipment commenced in September, 1959. Some buildings such as the entire acid plant, the unbleached screen building, the original boiler room and the engine room were completely demolished. In other cases, buildings of more recent construction were usable but the equipment had to be demolished and removed to provide space for new equipment.

The Woodfibre mill has an adequate water system which required only minor modification and replacement of some piping.

The steam power plant, built in 1947, has one 100,000 lb. per hr. oil fired boiler and two 100,000 lb. per hr. oil and hog fuel fired. One of these two has been modernized by equipping it with a Riley pneumatic spreader stoker and by some modification of the heating surface to give improved continuity of operation. If this conversion proves satisfactory, the second wood fired boiler will be similarly converted in the near future.

New kraft mill of Rayonier Canada at Woodfibre, B. C. which has started operations

The 1947 electric power plant has two 2000 kw. Elliott back pressure single extraction turbo-generators and a 2250 kw. generator, driven by a Pelton wheel. These generators were formerly supplemented by a 1917 vintage 2000 kw., 175 p.s.i. condensing turbine for emergency use. This has been discarded and in its place there is now a Canadian General Electric 3750 kva. 0.8 pf. 4160 v. generator driven; by a 3300 kw., 550 p.s.i. 725°F. condensing turbine. This is the largest condensing steam turbo-generator ever built in Canada.

By careful planning it was found possible to provide an adequate electrical distribution system by adding only one new power transformer.

Recovery of the digester liquor fuel value and chemical content is accomplished in a 570 p.s.i. 725° F. Babcock Wilcox & Goldie McCulloch recovery boiler designed to burn 855,000 lb. dry solids per 24 hr. The venturi scrubber, cyclone evaporator and all principal auxiliary equipment were furnished and installed by Babcock Wilcox & Goldie McCulloch. The recovery boiler draft fans, venturi pumps and feed pump are equipped with Canadian Westinghouse back pressure steam turbine drives.

Additional compressed air for use throughout the plant is furnished by a Broomwade 400 c.f.m. motor driven compressor.

A 9-ft. diam. by 175-ft. Traylor kiln with Peabody scrubber, and recausticizing equipment furnished and installed by Eimco Process of Canada, Ltd. are in the area formerly occupied by the sulfite acid plant. Eimco also furnished the lime mud filter.

Carrier vibrating conveyors by United Steel Corp., Ltd. handle make-up pebble lime rock and burned lime from the kiln.

Elevators delivering these materials to the storage bins were designed and furnished by C. W. Brockley, Ltd. of Vancouver. This company also supplied the burned lime screw conveyor to the slaker.

About half of the requirements of chips and hogged fuel will be delivered by barge from Rayonier's Marpole and New Westminster sawmills. Existing woodroom at Wood-fibre will furnish the other half. Chips are stored in three existing concrete silos supplemented by an open storage area. A Rader pneumatic system will transfer the chips to or from the storage pile. Unloading from the barges will be accomplished by means of a Colby double hammer-head grab bucket unloader. This has been erected on a new wharf 340-ft. long on which also are the belt conveyors to receive the chips and hogged fuel from the unloader. The piles and

for clearer colors at lower cost

PURECAL® O . . . a Wyandotte Key Chemical

PURECAL O produces the whiteness in paper coatings to bring out the brightness in colors. It is the purest of precipitated calcium carbonates, and the whitest coating medium in its price range. It gives paper surfaces excellent finish and printability. Find out how this Wyandotte Key Chemical can help you hold the quality and cut the cost of coating.

WYANDOTTE CHEMICALS

MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN

other main members incorporated in the wharf are all pressure creosoted. The Horton black liquor evaporator has four effects and has a surface condenser to give maximum heat recovery.

Five 12 by 55-ft. Dominion Bridge digesters and the foundation for a sixth one have been provided. They are fabricated from Lukens stainless clad steel. These digesters are installed in the original digester building in the area formerly occupied by three 18 by 45-ft. sulfite digesters of German manufacture. Two of these were in use from 1912 to 1958. Number three was installed in 1914. The useful lives of these old vessels however are not yet over as they will now serve as filtrate tanks for the brown stock washers. For this purpose they were moved bodily out of the digester building by tipping them over bottom end first and passing them out through suitable openings cut in the building wall.

Two 18-ft. sulfite digesters remain in the digester building for use as white liquor storage tanks in the new operation.

An entirely new steel-frame building with asbestos-cement siding adjoins the digester building. In this are installed a Sherbrooke centrifugal knotter, three Sherbrooke 8 by 16-ft. washers, two Cowan unbleached primary screens, one tailings screen, the Sherbrooke 6-ft. 6-in. by 14-ft. unbleached decker and a bleached decker of the same size. There also are a Cowan bleached screen and a battery of centricleaners moved from the abandoned former bleached screen room.

The ground floor of the washing and screening building contains two rectangular tile stock chests and a white water chest, the three of which together extend over the greater part of the length and width of the building between the ground floor and the second floor.

Motor control equipment and an electric center serving the digester building and the washing and screening building are installed over these stock chests.

Practically all bleaching equipment is new. By careful planning it was found possible to house this equipment in the existing bleach plant concrete structure built in 1937.

A six stage continuous bleaching sequence is provided including chlorination, hypochlorite bleaching, caustic extraction and chlorine dioxide bleaching. There are five new 8 by 12-ft. Dorr-Oliver-Long vacuum washers with Chemical Linings Co. tile vats. Three stages utilize existing batch reactors which were converted to down flow towers by modifying them and equipping them with Sherbrooke circulators and dilution nozzles.

The chlorine dioxide bleachers are the Sherbrooke upflow, down-flow type. These were fabricated and erected by Pacific Steel Erectors and lined by Chemical Linings Co. Four Sherbrooke thick stock pumps, four Dorr-Oliver-Long steam mixers and two Paper Machinery, Ltd. horizontal chlorine dioxide stock mixers are incorporated in the bleach plant arrangement.

Chlorine dioxide is manufactured in a generating plant located at operating floor level. The main components of this plant were designed and furnished by Electric Reduction Co. of Canada. Calcium hypochlorite bleach is produced in a fully automatic continuous plant located on the bleach plant operating floor. This equipment initially will be furnished lime slurry from the existing batch plant utilizing purchased burned lime. In the near future, however, it is expected that burned lime from the main kiln will replace this.

The old pulp drying machines will continue in use for the time being. One of these is of German manufacture and dates from 1912 when the original mill was built. The other machine was built by the Black Clawson Co. in 1917.

The bale make-up and handling equipment will be improved by replacing the hand operation with semiautomatic equipment which is being furnished by the Cranston Machinery Co., Inc. Tennant automatic bale tying machines also are being installed.

St. Francisville Paper Co.

Plans to proceed with an engineering program to double the capacity of the new coated printing paper mill at St. Francisville, La., were announced by Crown Zellerbach Corp. and Time, Inc., joint owners of the St. Francisville Paper Co.

The program will include a second paper machine for the manufacture of double-coated printing papers with a capacity of 80,000 tons a year, enlargement of the installation and essential supporting facilities. The capital investment involved is estimated at $25 million.

The St. Francisville mill, located north of Baton Rouge, includes the first paper machine to combine new blade coating and conventional roll coating in a continuous operation. Half the mill's production is used by Time, Inc., for its various publications, and the other half is marketed by Crown Zellerbach in the Midwest, East and South. The mill is under Crown Zellerbach management.

The new program is expected to raise capacity at St. Francisville to 160,000 tons a year.

St. Regis Paper Co.

Rhinelander Paper Co., Div.

Effective July 1, 1961, **Elton T. Krogel** was promoted from acting pulp mill superintendent to pulp mill superintendent of the Rhinelander Paper Co., Div. of St. Regis Paper Co.

Elton T. Krogel, St. Regis Paper Co.

Howard Paper Mills

An entry by Howard Paper Mills, Division of St. Regis Paper Co., won the Best of Show award at the 5th District Advertising Federation of American annual advertising awards competition held in Cincinnati, Ohio. The entry, a series of insert ads called "Discoveries in American Art" for the company's Maxwell Division, also won first place in the trade or business magazine advertising series class. The back of the inserts were ads for the company's Howard division. A record 575 entries were submitted by advertisers and agencies in Ohio, West Virginia, and Kentucky.

One of the ads won the Best of Show award last year in the Dayton Advertising Club's annual competition. Another in this series won an Excellence award this year in the New York Art Directors Club's 40th Annual Competition.

Staff

St. Regis Paper Co. announces the appointment of **Loren J. Matthews** as industrial engineer on the staff of Benton R. Cancell, executive vice-president in charge of operations.

St. Regis Paper Company announces that **James Russell** has joined St. Regis as group supervisor, Polymer and By-Products Research. He will report to Willard E. Carlson, manager of research. Initially, Dr. Russell will be located at the St. Regis Polymer Development Laboratory in Yonkers, N. Y. He will move to the new St. Regis Technical Center in Rockland County, N. Y., after its completion in the fall of this year.

STANDARD PACKAGING CORP.

Appointment of **Edwin R. Lord** as chief industrial engineer at Eastern Fine Paper and Pulp Div. of Standard Packaging Corp., has been announced. Mr. Lord joins the Eastern Division following several years in the management consulting and industrial engineering fields.

STANDARD PAPER MFG. CO.

Standard Paper Manufacturing Co. of Richmond, Va., has announced promotion of **George S. Johnston, Jr.,** from vice-president to executive vice-president, and election of Mr. Johnston and **Joseph E. Hoffmann,** vice-president and sales manager, to the Board of Directors.

TAYLOR FIBRE CO.

Taylor Fibre Co. has named **George J. Muller,** formerly manager of Technical Service, as manager of its recently expanded Special Projects Group. He is assisted by **Francis M. Guiney** and **Horace E. Scherer** as project engineers. Other Taylor Fibre engineers and designers are assigned to the group depending upon the requirements of the project undertaken.

This Special Projects Group is responsible for inquiries and orders requiring extensive or complicated engineering, new materials, new manufacturing techniques or sophisticated tooling. It works primarily with materials made by Taylor Fibre Co.—laminated plastics, vulcanized fiber and filament-wound reinforced plastic—but is also qualified to engineer complete assemblies involving other materials or components made from them. These include products fabricated from composites of laminated plastic or vulcanized fiber with metals, rubber and other materials.

WEYERHAEUSER CO.

George S. Allen, dean of the University of British Columbia's faculty of forestry, has been selected to head Weyerhaeuser Co.'s forestry research program, it was announced by Edwin F. Heacox, vice-president, timberland division. As director of forestry research, Dr. Allen's responsibilities will include the former duties of William H. Cummings, who has resigned as supervisor of the company's forestry research center.

With headquarters in Centralia, Wash., Dr. Allen will direct the 22-man staff of Weyerhaeuser's forestry research laboratories as well as the forestry research program on the

for brighter boxboard at lower cost

PURECAL® O . . . a Wyandotte Key Chemical

PURECAL O is a fine precipitated calcium carbonate specially developed for paper and paperboard coatings. It is exceptionally pure, white, and uniform. It provides more whiteness than any other coating medium in its price range. Find out how this Wyandotte Key Chemical can help you get crisper colors on cartons, at lower cost.

WYANDOTTE CHEMICALS

MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN

company's tree farms. Weyerhaeuser's forestry research covers a broad field in the natural sciences. It includes basic studies in forest soils, physiology, genetics, entomology, pathology, and biology. Investigations are carried on in several phases of silviculture, reforestation and protection with the overall objective of growing better trees faster.

Wyomissing Paper Products Co.

With the completion of new equipment now under construction, Wyomissing Paper Products Co. of Reading, Pa., will make an important expansion in the scope of its laminating operations. The company has just concluded a contract with the Inta-Roto Machine Co. of Richmond, Va., for the construction of machinery which will enable the company to laminate many combinations of paper, cloth, board, film and foils. Delivery of the machinery, which will be installed in the company's new plant at Tuckerton on the northern perimeter of Reading, is expected by the end of 1961.

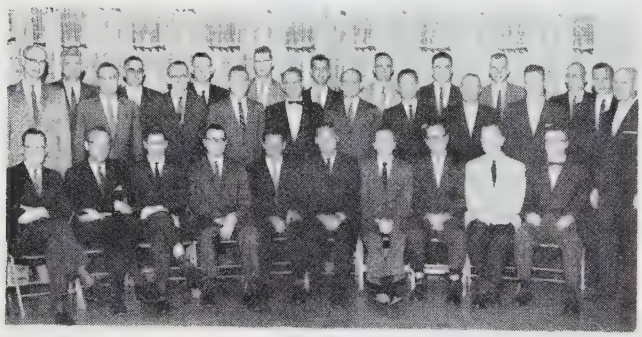
Educational Institutions

Institute of Paper Chemistry

Scientific Research Projects

Two more scientific research projects were recently authorized in the Pioneering Research Program of The Institute of Paper Chemistry.

At Yale University in New Haven, Conn., Ellis B. Cowling will receive funds for a 3-year study of "Mechanics of Degradation and Nature of Relationships Among High Molecular Constituents of Wood and Wood Fibers." Dr. Cowling is an assistant professor of Forest Pathology in the school of forestry at Yale University.



The group which attended the Sixth Industry Seminar held at The Institute of Paper Chemistry, June 11–30, 1961

At Lawrence College in Appleton, Wis., B. W. Coursen and R. H. Trumbore will receive funds to finance a 2-year study titled "An Exploratory Investigation of Antibiotics and Growth-Stimulating Agents in the Bryophyta (Bry'-o-fighta)."

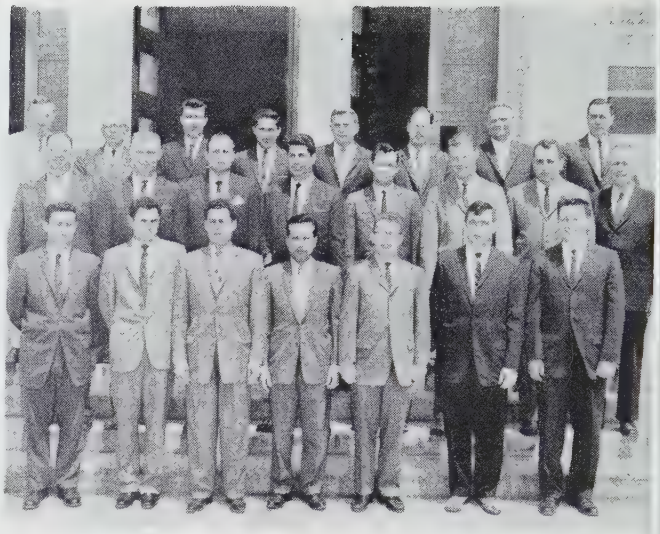
Six projects are now being financed by the Pioneering Research Program which has support of $125,000 a year from 24 companies and foundations, and is administered through The Institute of Paper Chemistry.

Lowell Technological Institute

Six men received B.S. degrees in paper engineering at 63rd commencement exercises of Lowell Technological Institute Sunday, June 11. A class of 138 were awarded B.S. and M.S. degrees with Dr. Martin J. Lydon, president, officiating.

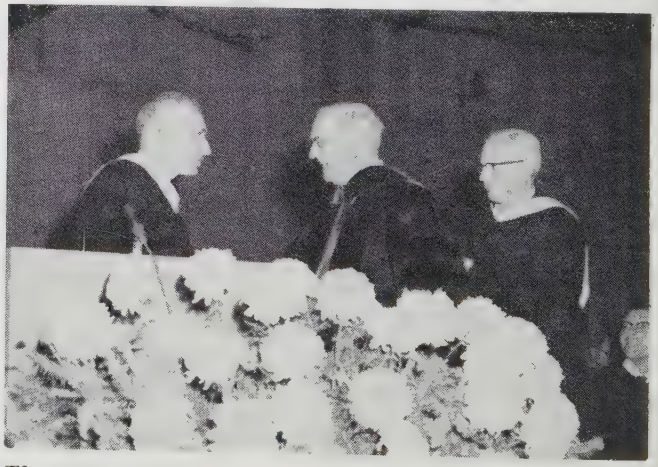
Summer Paper Course

Enrolled in the professional advancement course in Paper, Its Properties and Uses, held June 12 to 23 at Lowell Technological Institute in Lowell, Mass., were those shown, left to right. First row: Prof. Charles J. Higgins of the faculty; Ignacio Hernandez S., V. Primo Rivero E., and Crescencio Lopez D. E., all of Empaques de Carton Titan, Monterrey, Mexico; Richard A. Guthman, Jr., and Mark C. Balkcom of Montag, Inc., Atlanta, Ga.; Ernest J. Laios, Gilman Paper Co., New York. Second row: J. S. Crimi, IBM, Yorktown Heights, N. Y.; E. Neal Templin, Corn Products Sales Co., Seattle, Wash.; D. Carcano-Thiers and Rogelio Garza Trevino, Empaques de Carton Titan; Charles L. Bennett, Monadnock Paper Mills, Bennington, N. H.; Rober E. Loughman, Baird & Bartlett Co., Boston; L. H. Wirtz, IBM, Yorktown Heights; Prof. Edward M. Engel of the faculty. Third row: A. M. Clarke, Jr., Standard Packaging, Boston; Frederick C. Moesel, Corn Products Sales Co., New York; Jesus Varela I. and Victor E. Serrato C., Empaques de Carton Titan; Edward W. Little, Kendall Paper Co., Cambridge, Mass.; Hugh J. McCulloch, Columbia Pulp Sales, Ltd., Vancouver, B. C.; Robert High and Kenneth E. Fulton, Keever Starch Co., Columbus, Ohio. Absent from the picture was Charles E. Brookes, Dewey and Almy, Cambridge.



University of Maine

Thomas B. McCabe, president of the Scott Paper Co., was awarded an honorary Doctor of Laws degree by the



Thomas B. McCabe, president of the Scott Paper Co., is shown receiving an honorary Doctor of Laws degree at the 116th commencement exercises at the University of Maine. Making the presentation are University President Lloyd H. Elliott, left, and Vice-President Charles E. Crossland, right

University of Maine at its 116th Commencement exercises at the nearby Bangor Municipal Auditorium on June 11, 1961.

More than 6000 persons in the audience and many thousands more over television watched Mr. McCabe receive his degree from University President Lloyd H. Elliott.

The Scott Paper Co. has been an active member of the University of Maine's Pulp and Paper Foundation for many years.

Before making the presentation, Dr. Elliott read the following citation:

"A native of Maryland, a graduate and trustee of Swarthmore College recipient of many honorary degrees; following graduation from college in 1915, he became a salesman with Scott Paper Co., with which company he is still associated; at the age of thirty-three, he was named president of the company of which he has been a director since 1921; his exceptional ability and business acumen, his firm belief in the development and training of young men, his positive conviction that quality shall be foremost, combined with his capacity to create and direct vast industrial organizations, have made him one of our country's foremost industrial leaders; director of corporations; and officer in World War I; for nine years chairman of the Board of Federal Reserve Bank of Philadelphia, and three years chairman of the Board of Governors of the Federal Reserve System; his many and diverse public services, demanding rare ability and devotion, won him a presidential award of merit; a friend of education.

"In recognition of your interest in the State of Maine, your long and valuable services which have made you a public figure of first magnitude, your economic statemanship, vision, industry, and immeasurable achievements which have won for you the respect, admiration, and commendation of your associates, the Trustees of this University are happy to confer upon you the honorary degree of Doctor of Laws."

Miami University

Plans for increased industry support of Ohio's first collegiate paper technology program were laid by members of the Miami University Pulp & Paper Foundation. The meeting of representatives of the 16 member firms of the foundation came shortly after completion of the first full 4-year cycle of the

for smoother surfaces at lower cost

PURECAL® O . . . a Wyandotte Key Chemical

This Wyandotte Key Chemical for papermakers is a precipitated calcium carbonate produced by a unique double-refining process that assures exceptional whiteness, purity, and uniformity of particle size. Result: PURECAL O helps make paper surfaces smoother and whiter, and provides extra hiding power. See for yourself . . . call in your Wyandotte representative.

WYANDOTTE CHEMICALS

MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN

Pulp and paper company officials attending the University of Maine's second annual Pulp Institute and members of the faculty are shown in front of Aubert Hall, home of the university's pulp and paper technology program

Miami University paper technology program, marked by recent graduation of the program's first class of seven men. The Foundation was established several months ago to provide permanent form and identity to industry support which had been carried out by an industry advisory committee since the program first got under way early in 1957.

NORTH CAROLINA STATE COLLEGE

The Scholarship Committee of the Pulp and Paper Foundation, Inc., has awarded 55 scholarships with an aggregate value of $32,175 to students in the School of Forestry at North Carolina State College.

In announcing the awards, R. G. Hitchings, acting head of the college's pulp and paper technology program, said 22 scholarships went to new freshmen who will enroll in the pulp and paper technology curriculum in September and 33 scholarships for upperclassmen in the curriculum were renewed.

The first award scholarships to new freshmen, which range in annual value from $300 to $750 each, totaled $11,750.

The chairman of the Pulp and Paper Foundation's Scholarship Committee, H. Y. Charbonnier of the Union Bag-Camp Corp., Savannah, Ga., said that all states of the Southeast except one are represented by scholarship recipients—a fact which demonstrates the regional nature of the pulp and paper program at North Carolina State College.

SYRACUSE

Hardy L. Shirley, dean, State University College of Forestry at Syracuse University, announced the promotions of **Frank W. Lorey,** from assistant professor to associate professor of pulp and paper technology.

Scholarships

Eight undergraduate students majoring in pulp and paper technology at The State University College of Forestry at Syracuse University have been awarded scholarships

Trustees of Miami University Pulp & Paper Foundation at its annual meeting included (seated) P. S. Cade, Harding-Jones Paper Co.; Calvin F. Lloyd, Gardner Div., Diamond-National Corp.; Howard E. Whitaker, The Mead Corp.; C. E. Brandon, Miami University paper technology program director; C. C. Fracker, representing Dwight J. Thomson, Champion Paper & Fibre Co.; (standing) Bernard H. Bamer, Stone Container Corp.; Kenneth P. Geohagen, Howard Paper Mills Div., St. Regis Paper Co.; Harold M. Annis, Oxford Paper Co.; William Beckett, Beckett Paper Co.; R. P. Bertschy, Kimberly-Clark Corp., and R. W. Herr, Fox Paper Co.

sponsored by the pulp and paper industry: **James F. Giffune,** New York-Canadian Division of Paper Industry Management Association Award ($300); **John K. Harris,** Harold L. Austin Memorial Scholarship ($300), sponsored by Empire State Paper Association; **Raymond D. Bourdeau,** Pennsylvania, New Jersey and Delaware Division of Paper Industry Management Association Award ($300); **Gerard R. Brandt,** Allied Paper Salesmen's Association, Inc., of New York Scholarship ($500); **Kenneth B. Laffend,** National Starch Products, Inc. Scholarship ($500 per year, for two years); **David R. Haskins,** Fred C. Boyce Student Award ($200), sponsored by Paper Industry Management Association; **John R. Potter,** Empire State Section TAPPI Award ($500); and **John H. Conklin,** The Mead Corp. Award ($300).

Syracuse Pulp & Paper Foundation

The Syracuse Pulp and Paper Foundation, Inc., announced that it is increasing the amount of money appropriated for scholarships to students specializing in pulp and paper technology at the State University College of Forestry at Syracuse University to $10,000.

The announcement was made this week by Robert F. Vokes of Middletown, Ohio, president of The Syracuse Pulp and Paper Foundation, Inc., following a meeting of the Board of Directors at the Syracuse Forestry College campus. In addition, for the first time, five scholarships

for 1961–62 will be available to freshmen students entering the Syracuse Forestry College this fall (September, 1961).

During the 1960–61 college year, the Foundation awarded 20 individual scholarships amounting up to $450 each to sophomores, juniors and seniors majoring in pulp and paper technology at the Syracuse Forestry College.

According to Prof. F. W. O'Neil, chairman of the Department of Pulp and Paper Technology at the College of Forestry, The Syracuse Pulp and Paper Foundation, Inc., is presently composed of 24 corporate and over 70 individual members. Since its establishment less than a year ago, membership in the Foundation has continued to grow at an accelerated rate.

The Syracuse Pulp and Paper Foundation, Inc., has been established to interest science-oriented high school students in professional careers in the pulp and paper industry, fifth largest in the nation, and to provide financial assistance to qualified students enrolled in the pulp and paper technology curriculum at the Syracuse Forestry College.

Industry Suppliers

Air Reduction Chemical and Carbide Co.

A new, comprehensive bulletin just issued by Air Reduction Chemical & Carbide Co., a division of Air Reduction Co., Inc., discusses Vinol fully hydrolyzed polyvinyl alcohols.

The sixteen-page bulletin highlights a super hydrolyzed polyvinyl alcohol produced exclusively by Airco, Vinol 125, and fully hydrolyzed Vinol 230. Both grades are now available in commercial quantities from Air Reduction's new Calvert City, Ky., plant. The resin and film properties of Vinol 125 and Vinol 230 are described in detail.

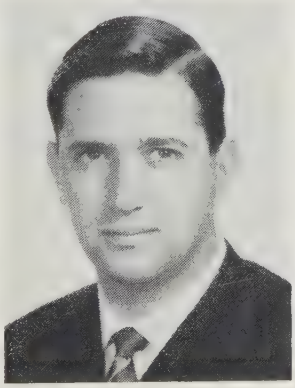
The use of fully hydrolyzed polyvinyl alcohols in the manufacture of paper, adhesives and textiles is covered in the first section of the bulletin. The second section covers physical properties and handling, including modifications by precipitants and extenders. Numerous graphs, tables and charts present data of interest to chemists and engineers in many chemical processing fields.

Allis-Chalmers Mfg. Co.

Appointments of **Henry M. Brundage** as manager of the Chattanooga district; **Thomas L. Dineen** as manager of the Cleveland district; **Andrew Wassell** as manager, utility sales; **W. W. Chalmers,** manager, industrial sales, Charlotte district; and has been announced by Allis-Chalmers Industries Group, and **Joseph M. Duncan** as manager of the North Central Region with headquarters in Chicago, has been announced by Allis-Chalmers Industries Group.

Appleton Woolen Mills

Appleton Woolen Mills announces the appointment of **Hans A. Schelke** as Lake States sales representative, effective immediately. Schelke's territory includes southern Michigan, eastern Ohio, and upper New York state.



Hans A. Schelke, Appleton Woolen Mills

Babcock & Wilcox Co.

Four personnel changes in the sales department of the Babcock & Wilcox Co.'s boiler division have been announced. **Seth M. Snyder** has been named Pittsburgh district sales manager to succeed **W. I. Collins,** who will retire September 1 after 35 years of service with the company. **J. W. Thompson** will become district sales manager in Charlotte, N. C., on August 1, succeeding Mr. Snyder. **J. E. Roberson** will move from the Atlanta, Ga., sales office to replace Mr. Thompson as sales engineer in Cincinnati, Ohio.

A graduate of Ohio State University, Mr. Snyder joined B&W following his graduation in 1936. Mr. Thompson has been with the company since 1942, and Mr. Roberson since 1951. Graduates of Georgia Institute of Technology, Messrs. Collins, Thompson, and Roberson represent classes of 1918, 1942 and 1951, respectively.

Bauer Bros. Co.

Bulletin P-37, just released by The Bauer Bros. Co., 1715 Sheridan Ave., Springfield, Ohio, describes the "Baueramic" ceramic cones for Bauer high velocity Centri-Cleaners. These cones are exceptionally resistant to friction, abrasion, heat and shock. They outlast hardest metallic alloys and cost less. They were developed by Bauer's cleaner research laboratory to overcome extreme wear conditions caused by abrasive pulp.

John W. Bolton & Sons, Inc.

14th Bolton Award

Edward L. Schuette, paper tester in the Quality Control Division of the Brown Co.'s Cascade mill at Berlin, N. H.,

being presented a check for $1000 in a special ceremony held at the mill recently in recognition of his winning the first prize for the essay he submitted in the 14th Annual Bolton Award contest on this year's subject, "Privileges of the Free Enterprise System," by A. L. Bolton, Jr.

Corn Products Co.

A new chemically-modified, anionic, thick boiling corn starch, Superior brand 3821 has been developed by Corn Products Co. for use as a wet-end additive for the paper industry. The chemically-bound phosphate which modifies the starch lowers gelatinization or cooking temperature 8 to 10°F., improves bonding characteristics of the starch, gives greater paste clarity and increases hot paste viscosity. Key advantage claimed for the new additive, or fiber-bonding agent, is the operational flexibility it lends to the manufacture of a wide range of paper types, from fine writing grades to sanitary and tissue papers.

Paper strength, can be increased by use of the new additive. If increased strength is not necessary, the manufacturer can make economical adjustments in pulp composition, filler materials, or surface size and maintain present sheet strength.

With this phosphate modified starch it is also possible to increase the amount of low cost filler materials in the paper

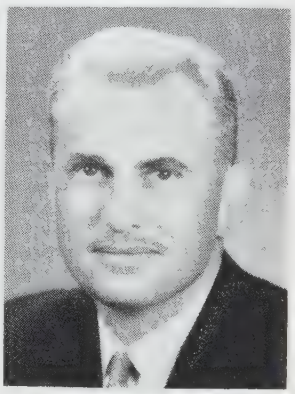
without sacrificing quality. The exceptional properties of the phosphate starch also result in retention of more pigment in the sheet. This is especially important where more expensive fillers are being used. The fiber-bonding properties of the new starch may make it possible to reduce the amount of surface sizing or, in some cases, eliminate it entirely without loss in wax pick.

DORR-OLIVER, INC.

A new 24-page brochure, Bulletin No. 3002, describes the complete line of Dorr-Oliver thickeners for chemical, metallurgical and industrial processing. The new brochure describes and lists standard sizes and specifications for the modern thickener designs and mechanisms resulting from more than 50 years of continuous engineering and design experience since the original invention in 1906 of the Dorr thickener. Single and multiple compartment thickeners are described having both center-drive and perimeter-drive rakes in a variety of configurations for unit operations in all the process industries.

DRAPER BROTHERS CO.

Draper Brothers Co. announces the appointment of **Fred Ihlenburg** as assistant sales manager in their Papermakers Felt Division at the home office in Canton, Mass. For the past three and one-half years he has handled service calls on the West Coast, operating out of the office of Walter A. Salmonson, their West Coast representative located in Portland, Ore.



Fred Ihlenburg, Draper Bros. Co.

E. I. DU PONT DE NEMOURS & CO.

Dyes and Chemicals Div.

Francis L. Shackelford, Jr., has been appointed manager of the Chicago district sales office of du Pont's Dyes and Chemicals Division, effective June 1, the company has announced. He succeeds J. A. Turner who is retiring at the end of August after a career of more than 42 years with du Pont. Mr. Turner will remain as a consultant until his retirement.

FULLER CO.

Major product lines for the chemical processing industries are described in a new 12-page two-color bulletin offered by the Fuller Co., Catasauqua, Pa. The new bulletin, G-3E, discusses design and performance characteristics of Fuller-Kinyon pumps, Airveyor pneumatic conveyors, Fuller-Huron Airslide fluidizing conveyors, rotary compressors and vacuum pumps, horizontal grate coolers, Fuller-Humboldt suspension-type preheaters, Sutorbilt positive displacement blowers and gas pumps, Lehigh induced-draft fans and Lehigh industrial exhausters. A separate section describes Fuller accessory equipment.

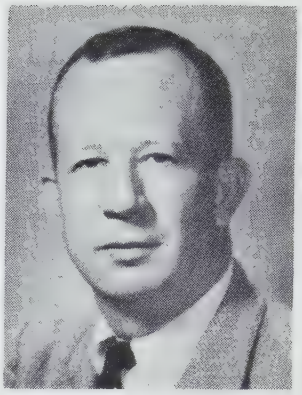
GARDNER LABORATORY, INC.

A new bulletin is available listing the optical as well as the physical test instruments manufactured by Gardner Laboratory, Inc., Bethesda, Md.

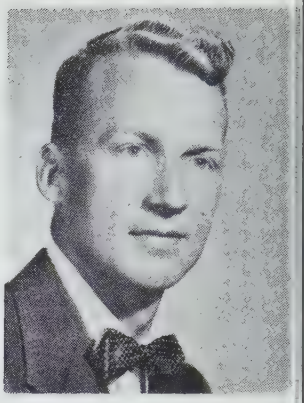
GENERAL AIRLINE & FILM CORP.

Antara Chemicals Div.

William C. Brunson has been named Midwest regional sales manager for Antara Chemicals Division of General



W. C. Brunson, General Aniline & Film Corp.



Richard H. Roberts, Jr., J. M. Huber Corp.

Aniline & Film Corp., New York, N. Y., succeeding G. A. Brost, who was appointed to the position of product manager—intermediates. He will be responsible for the sales of all Antara's chemical products including all surfactants, chemicals, UVINUL ultraviolet light absorbers, high-pressure acetylene chemicals, intermediates heavy chemicals, drilling additives and other specialty chemicals in the Midwest area of the United States, extending from North Dakota to Texas.

HERCULES POWDER CO.

Hercules Powder Co.'s Pine & Paper Chemicals Department announces the consolidation of the southeastern and southwestern states paper chemicals sales territories with headquarters in Atlanta, Ga. The New Orleans, La., office, formerly responsible for paper chemical sales in four states, will be closed effective Sept. 1, 1961. **W. E. Hamilton,** district sales manager of that office, moves to Atlanta, Ga., and is appointed assistant district sales manager of the new elevenstate territory. **D. D. Cameron,** presently district sales manager of the paper chemicals Atlanta office, is appointed district sales manager of the expanded territory.

J. M. HUBER CORP.

Richard H. Roberts, Jr., has been named manager of the J. M. Huber Corp. laboratory in Borger, Tex. The Borger laboratory is engaged in research and technical service for Huber's carbon black, kaolin clay and chemical products. The laboratory was recently enlarged.

RODNEY HUNT MACHINE CO.

George E. Soyka has been appointed exclusive sales agent in Mexico for the paper mill rolls manufactured by the Rodney Hunt Machine Co. of Orange, Mass. Dr. Soyka is affiliated with Manuel Del Castillo in the firm of Castillo y Soyka. From their office at Isabel La Catolica 45, Mexico (1) D.F., Mexico, Castillo y Soyka represent a number of American manufacturers in various Latin American markets.

I-T-E CIRCUIT BREAKER CO.

Albert L. Folden has been named manager—Commercial Apparatus Group for the Atlanta district office of I-T-E Circuit Breaker Co. In his new capacity, he will be responsible for the promotion and sale, of the company's lighter equipment for the control and distribution of electric power in commercial, residential and industrial applications in the state of Georgia.

INTA-ROTO MACHINE CO., INC.

Recent completion of a new 15,000-sq. ft. engraving building, with enlargement of the engineering building and general offices, marked the end of a two-year expansion

program by Inta-Roto Machine Co. and the affiliated Inta-Roto Engraving Corp., Richmond, Va. The new construction, increasing plant space by about 30%, was the fourth major expansion here in the past six years.

The engineering department, under Lawrence H. Haskin, director, and Claude Allen, chief engineer, now has a staff of 26, offering complete design and engineering service for development of new machines for manufacturers and converters of all flexible packaging materials.

Kohler Coating Machinery Corp.

The Kohler Coating Machinery Corp., Greentown, Ohio, announces the appointment of Stephen Thurlow Co., 1912 Minor Ave., Seattle 1, Wash., as sales agents in the states of Washington, Oregon, Idaho, and Montana.

Samuel M. Langston Co.

Kenneth W. Knorr has been named sales engineer, southeastern region, by Samuel M. Langston Co., Camden, N. J., manufacturers of corrugated container machinery, slitters and winders and sheet cutters for paper mills and converters.

Sheet Cutters

Samuel M. Langston Co. announces it will build Langston-Masson sheet cutters in Camden, N. J., for use on paper and board. The machines, available for a wide range of grades from finest tissue to boxboard, have been produced in London, England, for many years by Masson Scott & Co., Ltd.

Midland-Ross Corp.

Waldron-Hartig Div.

Bulletin No. 61-E2, "Waldron-Hartig Extruders and Auxiliary Equipment," describes the Waldron-Hartig line of extrusion process equipment from the new "T" line extruder through the various complete processing packages and Bulletin No. WM 61-6, "Waldron-Hartig Extrusion Coating and Laminating," describes the Waldron-Hartig extrusion coating equipment and technique.

Monsanto Chemical Co.

Monsanto Chemical Co. has announced that it has combined all of its product development and sales efforts on pulp and papermaking chemicals within a single division of the company in a streamlining and strengthening of its services to this major chemical-consuming industry. Effective July 1, the company's Organic Chemicals Division is responsible for all applied research, development, technical service and sales of over 40 Monsanto products for pulp and paper production, formerly spread among three of its operating divisions.

National Starch and Chemical Corp.

A technical brochure describing the recently introduced self-reacting resin latex, X-Link 2833, and its use for paper saturation is now available from the Resin Division of National Starch and Chemical Corp., 750 Third Ave., New York 17, N. Y. The 17-page brochure devotes a major section to illustrating the properties that make the new latex particularly suited for cellulosic and synthetic paper saturation.

The X-Link 2833 latex properties, especially useful in this application are: high tensile, good tear, flexibility, and elongation; excellent resistance to discoloration from heat, light, or chemicals; and high resistance to water and common solvents. Four graphs charting the performance of the material under specific conditions are included with these data.

In addition the brochure provides prospective users with information on the material's general properties, formulation, and other such promising applications as non-woven fabric binders, wallpaper coverings, vinyl organosol tie coats, adhesives, awning coatings, and textile finishes.

Staff

Irving Fischer has been appointed manager of the newly expanded Mid-Atlantic Division, National Starch and Chemical Corp., succeeding Jack Snyder who passed away suddenly on June 14.

Nichols Engineering & Research Corp.

Nichols Engineering & Research Corp., New York, announces that **E. Hart Rasmussen,** has been appointed manager of its Spray Dryer Division. In his new capacity Mr. Rasmussen will be in charge of the company's spray dryer sales to the chemical, ceramics, electronics, pulp and paper, food and flavoring, pharmaceutical and allied fields.

Oakite Products, Inc.

A concise, up-to-date compilation of the most modern methods and materials currently used in steam-detergent cleaning is presented for quick reading in a new, illustrated booklet just released by Oakite Products, Inc., 115A Rector St., New York 6, N. Y., manufacturers of specialized chemical compounds for industrial cleaning and related operations.

The booklet, entitled "How To Get The Most Out of Steam Cleaning With Oakite Specialized Detergents," offers valuable tips on steam cleaning in general and lists the six essential properties which all effective detergents used in steam cleaning should have. It also features pictures and technical specifications of the Hurriclean steam-detergent gun and the new, lightweight steam pistol plus a descriptive outline of the more successful materials now used in steam-detergent cleaning.

Pap-Tex Color & Chemical Co., Inc.

At the annual meeting of Pap-Tex Color & Chemical Co., Inc., the following officers were elected: **Sol Markowitz,** president and **Robert W. Pattison,** treasurer. Pap-Tex Color & Chemical Co., Inc., is located in North Wilbraham, Mass., and manufacture chemical specialty formulations for the paper, textile, and leather industries as well as distributors of dyestuffs and heavy chemicals.

Pfaudler Permutit, Inc.

Buyer's Guide

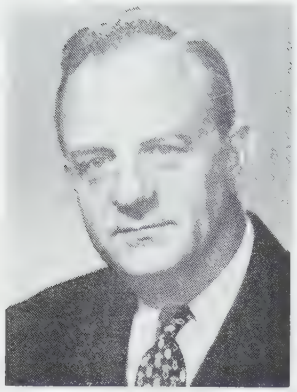
A new 1962 Buyer's Guide, Bulletin 1010 of interest to all industries which handle or process liquids or gases, is now available from Pfaudler Permutit, Inc., 1131 West Ave., Rochester, N. Y.

The 16-page buyer's guide is divided into two primary sections, one dealing with Pfaudler products, the other with Permutit products. Among the former are items of process equipment fabricated from Glasteel, Nucerite, stainless steel, titanium, zirconium, tantalum and other materials for corrosion resistant services such as reactions, distillation and evaporation, drying and blending, centrifuging, heat transfer, filling, storage, agitation, valving and piping. Permutit offerings described include equipment for water treatment, ion exchange, gas analysis, aeration, flow rate metering and control, demineralization, and waste treatment.

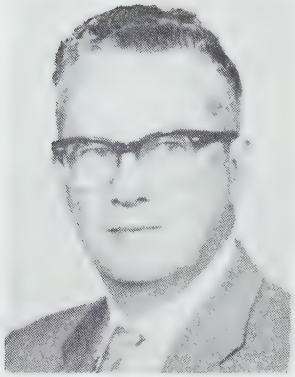
Penick & Ford Ltd. and Morningstar-Paisley, Inc.

Penick & Ford Ltd., Inc., and Morningstar-Paisley, Inc., have announced that their boards of directors have approved a plan for the merging of the businesses of their two companies.

Penick & Ford Ltd. is a major corn refiner producing starches, syrups, dextrines, oils and fats. In addition it manufactures and distributes an important line of pack-



J. E. Killinger, Penick & Ford Ltd., Inc.



L. S. Poer, Penick & Ford Ltd., Inc.

R. E. Brouillard, Penick & Ford Ltd., Inc.

W. S. Russell, Penick & Ford Ltd., Inc.

aged foods. The business of Morningstar-Paisley, Inc., offers Penick & Ford the opportunity to expand into new lines of operation, particularly into the potato starch and chemical fields. The business of Morningstar-Paisley, Inc., includes potato starches and dextrines, water-soluble gums and liquid industrial adhesives, synthetic resins for the paper industry as well as polyvinyl acetate emulsions.

Staff

O. H. Tousey, vice-president of Penick & Ford Ltd., Inc., announced the following executive changes in the Corn Refining Division. These changes are effective July 1, 1961. **J. E. Killinger** is promoted to the position: vice president—product application and development. This is a new division of the company which resulted from a long-felt need to expand the base of application of corn-derived products. **L. S. Poer** is promoted to the position: vice-president and director of marketing for the food industries and allied trades. **R. E. Brouillard** is promoted to the position: vice-president and director of marketing for the paper and textile industries. **W. S. Russell** is promoted to the position: assistant to the vice-president.

Richard H. Dillinger has been appointed manager of starch sales, a newly-created position at Morningstar-Paisley, Inc., New York City. Mr. Dillinger will coordinate and be responsible for sales of bulk and modified tapioca and potato starch as well as promotion of ethylated, oxidized and cationic starch derivatives, dextrine products and pregelatinized starches.

Pennsalt Chemicals Corp.

James McWhirter, general manager of Industrial Chemicals Division, Pennsalt Chemicals Corp., has been elected a vice-president of the company.

Pyroxylin Products, Inc.

Pyroxylin Products, Inc., of Chicago, announces a new series of Proxmelt compositions made from ethylene-vinyl acetate copolymer resin concentrates in waxes, micros and other vehicles for immediate delivery. These highly versatile compositions are the latest addition to the list of Proxmelt Concentrates—a long established line of synthetic rubber dispersions in convenient dispersible form.

Almost a score of these new formulas are offered, embodying differences in type, viscosity, concentration, and vehicle. A complete list of all Proxmelt Concentrates, including this new series, is available for the asking to laminators, coaters, wax blenders, paper converters, and package manufacturers. Write to Pyroxylin Products, Inc., Chicago 32, Ill.

Research-Cottrell, Inc.

The latest techniques and equipment for air pollution control are presented in a new 12-page, illustrated brochure (Bulletin 500) published by Research-Cottrell, Inc., Bound Brook, N. J., manufacturer of industrial gas cleaning equipment.

Rice Barton Corp.

J. Peter Munton, formerly chief engineer of Rice Barton Corp., Worcester, Mass., has been appointed manager of sales, Western Region, and will be based in Portland, Ore.

S & S Corrugated Paper Machinery Co.

Automatic Cut-off

A completely new precision rotary cut-off, just introduced by S & S Corrugated Paper Machinery Co., Inc., offers the widest range of sheet cutting lengths available to the paperboard industry. The Model-JL automatic cut-off can cut an endless web of corrugated or solid fibreboard, moving at speeds up to 650 f.p.m. or more, into sheet lengths ranging from 25 to 240 in. Further, two different sheet lengths can be cut simultaneously. Box plants using the Model-JL will find the added flexibility a competitive advantage since it will allow them to schedule more economical production runs.

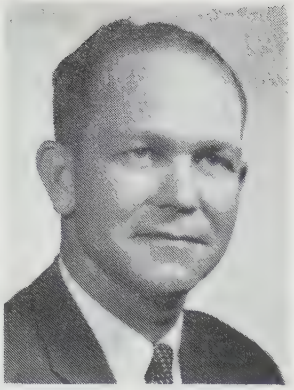
Automatic Order Changing System

A long step towards the paperboard industry's ultimate goal of complete automation has been made through the development of an "automatic sequential order changing system" by S & S Corrugated Paper Machinery Co., Inc., Brooklyn, N. Y. In an industry dominated by short run orders, both machine and man-hour time can be costly, making quick, automatic changeover an important economic consideration. This new S & S system is the optimum in fast changeover and maximum utilization of corrugated paperboard production.

Designed as an integral part of the new S & S "700" Corrubiner, the system makes possible rapid changeover from order to order in the machine's final operation of scoring, slitting, and cutting, without shutting down the machine, and with the only a momentary slowdown of high speed production flow. The entire order change cycle takes only 32 sec.

Sequential automatic order changing is a step-controlled rather than a time-controlled sequencing that automatically takes full advantage of optimum time for each stage of order changeover. As each step is completed, the next one is automatically actuated and there is no built-in time delay to slow the changeover cycle; time-controlled switching requires setting the machine for the maximum time required for any operation. The completion of each step triggers the next one in a chain-reaction sequence that not only eliminates waiting time, but also assures that no operation will take place until the preceding step has been completed.

J. Peter Munton, Rice Barton Corp.



Marcus H. Davis, Virginia Chemicals & Smelting Co.

TEXAS GULF SULPHUR CO.

Herbert R. Miller has joined the sales department of Texas Gulf Sulphur Co.

SPROUT-WALDRON & CO., INC.

Pulp Mill Machinery Seminar

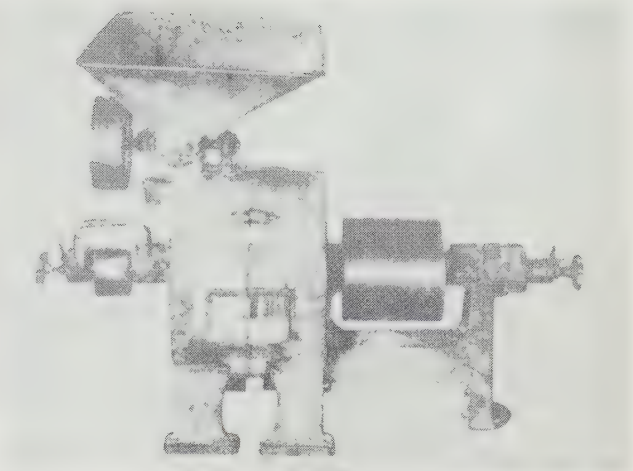
Twenty-one of the Sprout-Waldron sales and home office staff concerned with the marketing of Sprout-Waldron's line of pulp refining and stock preparation equipment as sold the pulp and paper industry gathered in Muncy for a complete reviewal of the company's recently expanded product line.

Sessions were devoted essentially to a consideration of what the newer designs as well as the older ones would do for the industry for which they were designed. Sessions too were devoted to a discussion of the design features now incorporated in all of the various models so that there could be no question as to the men's familiarity with the features which Sprout-Waldron contends makes its machines stand out as superior to competitive units.

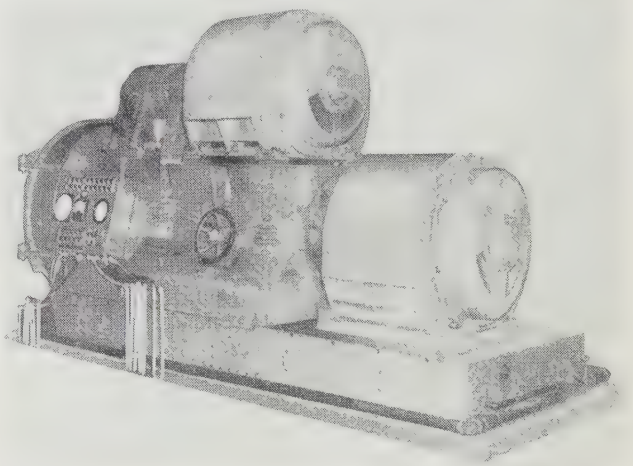
STICKLE STEAM SPECIALTIES CO.

Bulletin 115 covers steam traps for medium and high pressures manufactured by Stickle Steam Specialties Co., 2215 Valley Ave., Indianapolis 18, Ind. Known as Series 100, the traps are designed for drainage of cooking, drying, heating, and other processing equipment operating at steam pressures from 1 to 250 lb. Capacity range of the series if 500 to 3000 lb. per hr.

At the Sprout Waldron Pulp Mill Machinery Seminar



Sprout-Waldron's first machine of the disk-type employing French Buhr stone mills built in 1883



The newest refiner in the Sprout-Waldron product line, a double disk machine incorporating many very unique features distinguishing it from other double disk machines heretofore on the market, capable of receiving as much as 3000 hp.

TESTING MACHINES, INC.

For those interested in research, development or quality control, a new eight page comprehensive listing of 1239 physical testing machines for all industries obtainable from one source is now available to technical and purchasing personnel.

The equipment has been compiled from world wide sources, including units manufactured by Testing Machines, Inc. and many other prominent instrument and testing machine manufacturers.

This grouping is the result of 42 years cumulative effort. Technical and purchasing personnel, government agencies and educational institutes will find it a valuable reference manual for their informational files. Write to Testing Machines, Inc., 72 Jericho Turnpike, Mineola, N. Y.

VIRGINIA CHEMICALS & SMELTING CO.

Marcus H. Davis had joined the Virginia Chemicals & Smelting Co. in the newly created position of product manager, paper chemicals. On this assignment Mr. Davis will continue the work of developing consumer product application for the new paper chemicals which the research staff has been expanding through their market research program.

WARREN PUMPS, INC.

Warren Pumps, Inc., Warren, Mass., has promoted

Richard D. Butler, Jr., to manager of its Boston sales office. He replaces **Parkman A. Collins** recently retired after 34 years' service with Warren.

Wyandotte Chemicals Corp.

Election of **Carl Smith** as vice-president—industrial chemicals marketing of Wyandotte Chemicals Corp. was announced today by President Robert B. Semple.

General

Brazil's paper output has grown five-fold in the last 25 years. This year about 60 factories will produce a total of some 560,000 metric tons. But the industry has failed to keep up with demand. Last year Brazil had to import 83,500 metric tons of cellulose and 184,000 tons of newsprint—worth a total of $47 million—chiefly from Canada, the U. S., and the Scandinavian countries. This year it will have to import some 170,000 tons of paper.

To help meet the swelling demand, a number of companies are wrapping up on planning expansion programs. Among them:

Lutcher Celulose e Papel S.A. will build a pulp plant in Parana with the aid of a $4.7-million Inter-American Development Bank loan. Total cost: $13 million.

Rigesa S.A. Celulose, Papel e Embalagens, partly owned by West Virginia Pulp and Paper, has upped its capital by a third in order to double paper output to 12,500 tons per year by '63. West Virginia's new investment is around $1.7 million.

Visking do Brasil S.A., owned by Union Carbide, the Visking Co., and the Brazilian Matarazzo group, is installing $1.5-million worth of new machinery to step up production of regenerated cellulose.

Alcantara S.A. has just completed a cardboard plant outside Rio with an estimated output of 7,200 tons per year.

Industrias Klabin do Parana, Brazil's largest paper producer, is midway through an expansion program designed to double newsprint output, and is erecting a new plant to turn out 200 tons per day of kraft paper.

Industria de Papel e Papelao Rio Claro S.A. is building a $1.5-million paper and cardboard plant at Rio Claro, in Sao Paulo.

Folding Paper Box Association

William D. Hall, director of research for the Folding Paper Box Association of America, retired July 1, 1961. Mr. Hall has been in charge of the association's technical and production activities for the past 10 years, and on behalf of the association, served on various packaging organizations' committees. While his plans have not been completely formulated, he expects to utilize his broad experience in the graphic arts industries as a consultant in the production and management fields.

National Paperboard Association and the Fibre Box Association

Emergency National Headquarters

The National Paperboard Association and Fibre Box Association, recognizing the need for preparedness, maintain a joint national emergency headquarters which would be activated in event of nuclear attack. It is situated in a well equipped and protected shelter located in the Virginia countryside about 45 miles west of Washington, D. C. The shelter contains essential records, directories and other information which will be needed to carry on the work of the Associations and their respective industries should the present headquarters become inoperative. While many companies seeing the need to be prepared have protected their vital records and made plans for emergency operations, these are the only trade associations known to have actually established relocation headquarters.

Approach to farmhouse containing emergency national headquarters of National Paperboard Association and Fibre Box Association

The records and services of National Paperboard Association, whose 92 members produce approximately 90 % of total United States output of paperboard and Fibre Box Association with 110 members producing about 80% of the nation's corrugated and solid fiber shipping containers would be of great importance in a post-attack period.

The present headquarters of both Associations are located in Chicago with offices in New York, Washington, and San Francisco. If a major nuclear attack were made on the United States, it is assumed that the offices of the Associations would be unable to function and complete authority would then be transferred to the emergency headquarters.

Albert W. Luhrs, executive manager of both National Paperboard Association and Fibre Box Association, established this site for operating the associations in the event of need. The sheltered emergency headquarters has been constructed underground in the Virginia farmhouse of Mr. Luhrs. The location is well suited and is adequately protected to withstand the rigors envisioned subsequent to a nuclear attack on the United States. It is a sufficient distance from any large city which would be a prime target and is protected from the dangers of radioactive fallout as recommended by the Office of Civil and Defense Mobilization. The shelter is a room about 12 by 16 ft. constructed inside the basement area thus providing double walled protection against radiation. Further safety from the radiation hazard is assured by the surrounding hills and water ponds. The use of the earth as a barrier constitutes one of the best and most economical means of absorbing radiation. In addition, a wind direction indicator and a radiation measuring device in the shelter would reveal the direction and intensity of the fallout.

The shelter is designed as a combination living quarters and work space, fully equipped with the recommended emergency and safety devices. It is stocked with food and water rations, emergency power, lights, candles, first aid material, ventilating system and other items necessary for survival in an emergency.

Ontario Research Foundation

H. Borden Marshall, director of the department of chemistry, Ontario Research Foundation, Toronto, has been named winner of the Montreal Medal of the Chemical Institute of Canada. Presentation of the gold medal was made during the 44th Canadian Chemical Conference and Exhibition in Montreal, August 3–5, 1961. The medal is awarded for significant leadership in, and outstanding contribution to the professions of chemistry and chemical engineering in Canada.

Dr. Marshall is well known for his research in pulp and paper. Author of 28 technical papers, and holder of 22 patents, he was recently in the news because of his outstanding work in developing a new recovery system for chemicals used in the sulphite pulp industry. He has done significant research in the utilisation of waste sulphite liquors, developing methods for extracting vanillin and other products.

Active in professional affairs, Dr. Marshall has occupied many responsible professional posts during the past two decades. He was Chairman of the Board of Directors, Chemical Institute of Canada, from 1959–60 and has been prominent in the activities of four other professional organizations.

Water Pollution Control Federation

Highlighting 34 years of progressive water pollution abatement, 34th annual meeting of the Water Pollution Control Federation will be held in Milwaukee, Wis., Oct. 8–12. "Industry Day" will be Wednesday, October 11. The idea of an entire day devoted to industry's waste problems has proved quite popular. Special emphasis will be placed on the pulp and paper industry, with John G. Strange, president of the Institute of Paper Chemistry, Appleton, Wis., guest speaker at the Industry Luncheon. Co-sponsors of Industry Day are the National Council for Stream Improvement, the Institute of Paper Chemistry, The Sulphite Pulp Manufacturers' Research League, and The Northwestern Pulp and Paper Association.

Pulp, Paper, and Board—Economic Review*

It appears that "X marks the spot" for the pulp, paper, and paperboard industry in 1961. The downward slope of the total paper and board production trend line during 1960 is apparently being more than offset by a somewhat steeper upward trend line in 1961, thereby forming a graphic "X" on chart paper. The upward trend is expected in both the paper and paperboard grade groups. However, building paper and board may be slower in showing an uptrend. On the calendar, it appears that "X will mark the spot" at approximately midyear, possibly sooner, when the 1961 upward total paper and board production trend line will cross the downward line of 1960.

According to forecasts, which displayed restrained optimism, output of paper and board was expected to increase 2% in 1961 over 1960. However, as of late April, and during May, industry executives were heartened by the substantial strengthening in new orders for most grades, particularly for paperboard. For the first time in many months, order-backlogs have been built up by many mills and industry ratios of total production to capacity have been at a higher level in recent weeks.

As one Department of Commerce Field Office states, in referring to the current situation, "Again there comes the word of some encouragement over the turn of attitudes and demand during the past 30 days." This observation aptly portrays a renewed spirit of optimism reported by Commerce Field Offices in various sections of the country. Industry executives now seem to expect demand and output for the year to exceed earlier forecasts. Though not every mill nor every grade is experiencing the same strengthened demand, Commerce Field reports state that some companies booked 5 to 10% more new orders during May than in May, 1960.

The current increased consumer demand is being reflected almost immediately at the mill level. This is the consequence of merchant and converter inventories having remained at comparatively low levels relative to sales volume. Commerce Field Offices advise that merchants and converters reported pipeline inventories unchanged through mid-May. However, as the level of actual consumption increases, it could be anticipated that inventories would also be enlarged, thereby adding to new orders and production. Further, it could develop that tendencies toward price strengthening would likewise lend some incentive toward inventory accumulation somewhat above recent stock-sales ratios.

The industry is in an excellent position to meet an enlarged demand for its production, not alone from the standpoint of sufficient capacity but also as a result of numerous plant modernizations, improved operating efficiencies, and general cost reductions in manufacturing and distribution. For that matter, both current and long-range plans for most companies call for still further modernization and increased efficiency, and, as time goes on, some additional new capacity.

Raw materials for the industry have continued in good supply in all fields at steady prices. During the first quarter of 1961, pulpwood consumption was slightly greater than in the first quarter of 1960, while the production of wood pulp of all grades was down a little. The principal factor sustaining the level of pulp production during the first quarter was the important increase in exports of about 22% over a year ago. Further, some increase occurred in pulp inventories at mills. Actual consumption of wood pulp by the paper and board industry was down 3.3%, while nonpaper grades of pulp declined 8.8%. Waste paper continued at a comparatively low level, consumption running about 5.5% below last year's first quarter. A more detailed analysis of raw material trends appears in the following section of this report.

Domestic production of all grades of paper totaled 3.9 million tons in the first quarter of 1961, declining 2.4% from a year ago. Paperboard output of 3.8 million tons was down 3.2% and construction paper and board, at 672,000 tons, was down 13.4%. The lagging demand for various grades of building paper and building boards has been a significant factor in reflecting the lowered level of total paper and board production, which amounted to 8.4 million tons in the first quarter of 1961, a decline of 3.7% below the same period in 1960. However, recent building trade reports point to a noticeable upturn in new housing starts and construction in general. This factor should have a favorable influence on the demand for building material and assist in bringing the output of these grades to at least the level of a year ago, if not higher, during the third and fourth quarters.

Frequent reference has been made in earlier issues of this report to intensified market research and new product development on the part of the industry. A recent example is a new form of newspaper color advertising, the preprinted newspaper advertisement, which has grown in the past 2 years from an experiment to an established medium of advertising. Preprinted in full color gravure, delivered to the newspaper in rolls, it is run with the regular newspaper press run, the back of the insert being printed by the newspaper with standard editorial and/or advertising matter.

Printed on either roto newsprint or regular newsprint grades, the advertising is in lifelike color of uniform quality in every newspaper carrying it. Newspapers can overprint on the preprinted side, carrying such localized material as dealer names, coupons, regional prices, and testing copy.

The medium offers great flexibility in publication dates and can be made to fit in with or spearhead special marketing plans. Its attractive appearance makes it specially useful for display and merchandising prior to or concurrently with the appearance of the ad. Substantial newsprint tonnage may result from this development.

W. LeRoy Neubrech
Assistant Director for Pulp, Paper, and Paperboard
U. S. Department of Commerce

* Pulp Paper and Board Industry Report 17, No. 2 (June, 1961).

DIVISIONS AND COMMITTEES

Authorized Committee Assignments

The following new committee assignments were made during July, 1961. The total number of assignments now active in the 63 TAPPI technical committees is about 360. An identifying number is given by TAPPI Headquarters to each work assignment made by a committee chairman and approved by the appropriate division chairman. Assignment numbers should be requested for *all* activities of technical committees. A separate series of numbers is reserved for each of the technical divisions.

Assignment no.	*Committee*	*Title and objective*	*Committeeman in charge*
		CORRUGATED CONTAINERS DIVISION	
3008	Industrial Engineering	"A Measure of Productivity" to indicate the trend of productivity within an individual company compared to a group of companies.	L. C. Wightman
3009	Industrial Engineering	"Definition of Industrial Engineering Terms" standardization of terminology.	J. C. Sprague
3010	Industrial Engineering	"Manual of Supervisory Training on Industrial Engineering Subjects" to present outlines for supervisory training in industrial engineering subjects to supplement work already underway by the Production Committee.	H. A. Buckley
3011	Industrial Engineering	"Industrial Engineering Approach to the Control of Waste" recommendations for waste reduction.	L. C. Wightman
		ENGINEERING DIVISION	
4040	Chemical Engineering	"Bleach Tower Inventory Nomograph" technical information sheet.	A. J. Chase
4041	Drying	"Psychrometric Chart"	F. G. Perry
4042	Drying	"Psychrometric Data" review Data Sheet Nos. 83 and 83A.	
4043	Drying	"Paper Machine Drying Rate" to review data published 1951.	
4044	Process Instrumentation	"Instrument Flow Symbols" to provide the Pulp and Paper Industry a set of standardized flow symbols which will be compatible with those recommended by C.P.P.A. and I.S.A.	D. Morrissey
		PAPER AND BOARD MANUFACTURING DIVISION	
5000	Fourdrinier	"Considerations in Couch Pit Design" to determine factors to be considered in couch pit design, such as, tonnage, level control, agitation, consistency, and power.	H. H. Mullins
5001	Fourdrinier	"Revise TAPPI Data Sheet No. 5" update data sheet to encompass modern machine widths and speeds.	R. W. Peters
		RESEARCH AND DEVELOPMENT DIVISION	
7006	Statistics	"Third EVOP Course" to hold a 2-day course in evolutionary operation.	To be handled by TAPPI Headquarters
7007	Forest Biology	"Subcommittee on Bibliography" to make periodic reports on new references on environmental and genetic influences upon the quality of trees for pulpwood. These reports will serve as supplements to a bibliography which has been approved by TAPPI for publication as a monograph.	L. Besley
7008	Statistics	"Statistics Course" to hold 11th Statistics Course.	W. Haselow

Coating and Graphic Arts Division

Adhesive Studies Subcommittee

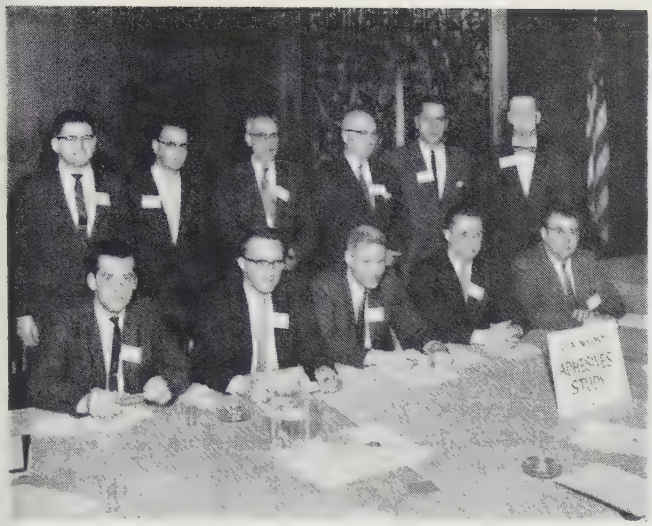
A meeting of the Adhesive Studies Subcommittee of the TAPPI Coating Committee, Committee Assignment No. 910, was held on May 9, 1961, during the 12th Coating Conference at the Statler Hilton in Buffalo, N. Y.

Based on the response to the questionnaire circulated by the subcommittee to the coating industry and adhesive suppliers, major interest is in the fields of water retention and adhesive distribution.

Some work has been published on these phases of coating application, in both paint and paper journals. Bayard L. Carlson will head up a literature survey to collect information on past work and test methods.

Upon completion of the survey, etc., Mr. Carlson will prepare a proposal for subcommittee study. Members are urged to lend Mr. Carlson all the assistance possible since this is quite an ambitious project.

A. S. Landers requested the subcommittee to consider the



preparation of data sheets, glossary of terms, and routine control methods for TAPPI.

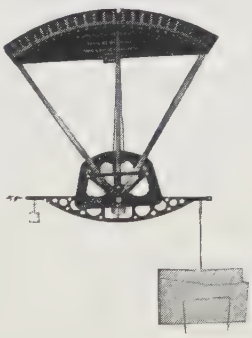
Mr. Cushing observed that the objectives of the subcommittee must be defined. If possible, comments from paper and board manufacturers on their specific problems should be gathered. We should also attempt to ascertain the future adhesive requirements of paper and board coaters—what do they want in the next five or ten years. This would serve as a guide to adhesive manufacturers and would be of great benefit to the paper industry.

The next regular meeting will be held during TAPPI week, February, 1962. If subcommittee business requires it, Mr. Cushing will notify members for a special meeting in the fall.

R. L. Savage, *Secretary*

THWING-ALBERT
BASIS WEIGHT SCALES

Known the world over as Precision Basis Weight Scales. Have accuracy to meet laboratory requirements yet are rugged enough for production requirements.



Ranges from 1 gram full scale direct reading to 400 pounds ream weight. Feature anti-friction weighing. Differential models also available.

Thwing-Albert means accuracy

THWING-ALBERT
INSTRUMENT COMPANY
5383 Pulaski Avenue
Philadelphia 44, USA

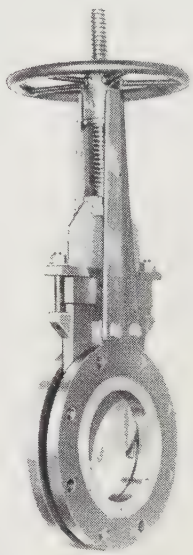
#168

FABRI-VALVE

TRADEMARKS OF QUALITY

FABRI-VALVE

DI-FAB



VEEPORT METERING

T-VALVE

FABRI

SELECT-A-FLOW

manufacturers of
WEDGE GATES
STOCK VALVES
BUTTERFLY VALVES
CHECK VALVES
DIGESTER VALVES
V-PORT METERING

FAB-VALVE

FAB-FORM

FABRIFORM

TRADE MARK
FABRI-VALVE
COMPANY OF AMERICA
91 N. E. RUSSELL ST.
P. O. BOX 4352, PORTLAND 8, OREGON

Process Instrumentation Committee

During the past few years, industry in general and the pulp and paper field in particular has experienced decreased earnings due in great part to increased costs of labor, raw materials and replacement equipment. Competition also enters into the picture and there is every indication that this will become more intense.

The Process Instrumentation Committee feels that the proper use of instrumentation is one method to reduce cost and enhance quality.

There is no question that an automated process is more efficient than one manually operated. The petroleum and chemical industries have for years employed instrumentation to the *n*th degree. Without it, their products would be far more expensive and less uniform than at present.

Improved uniformity of process (thus better quality) and in most cases a reduction in manpower and raw material usage is a direct result of instrumentation. In addition, accurate data are made available from which realistic cost analysis can be prepared.

Our committee is trying, through various technical programs to present to the industry a clear picture of the advantages the application and the maintenance of such equipment.

Project 775—Principles of "On the Machine" Moisture Measuring Systems

With reference to the article "Principles of 'On the Machine' Moisture Measuring Systems—TAPPI Project 775," attention is called to the ommission of our Stickle moisture control system in the above article appearing in the June, 1961, issue of *Tappi* by Mr. Hurm of Beloit Iron Works.

Since our system has been installed on over 125 paper machines it is now replacing several of the systems mentioned in the article, naturally we assume that this omission was an oversight.

It will be greatly appreciated, therefore, if you will publish all or a portion of this letter along with the enclosed description and illustration of the Stickle moisture control system.

F. A. Stickle, *President*
Stickle Steam Specialties Co., Indianapolis, Ind.

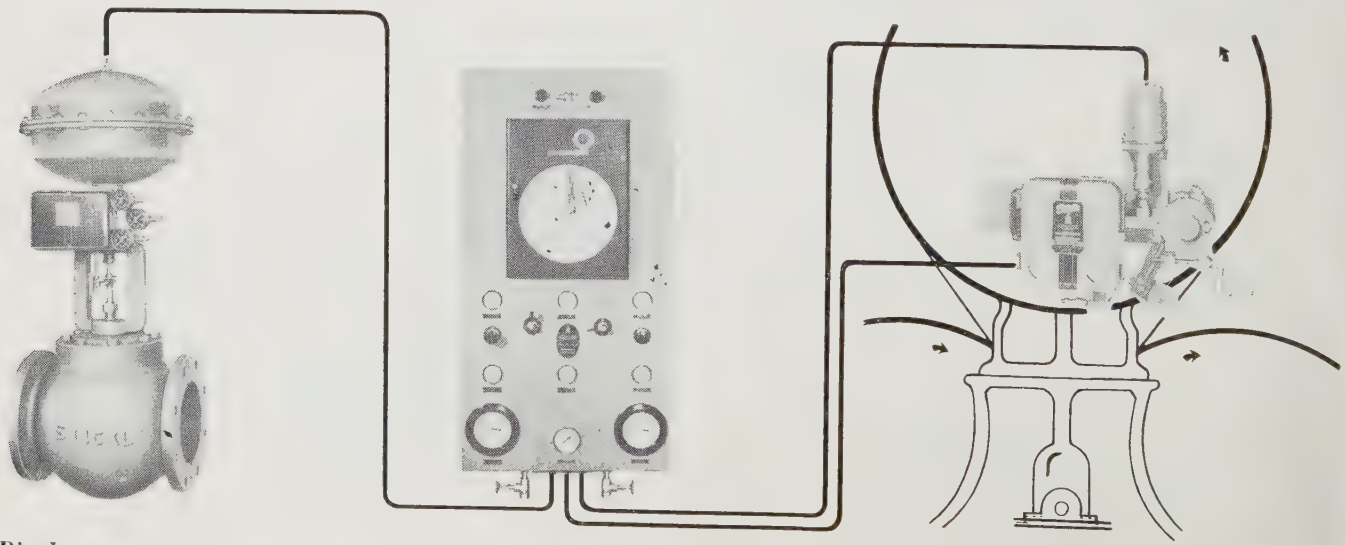
THE STICKLE MOISTURE CONTROL SYSTEM

The expansion and contraction of a sheet as it passes over the driers is used by the Stickle moisture control system to regulate steam flow to the driers. Sensing element is a dynamically and statically balanced tension roll located at a strategic point in the machine. This roll is hard chrome plated and turns on self-aligning ball bearings. The draw of the sheet, due to wetness or dryness actuates the moisture detector, causing it to send out a pneumatic signal in direct ratio to the amount of draw subjected to the tension roll. This signal travels to the control panel (center) and then to the diaphragm motor valve (left) which increases or decreases the amount of steam admitted to the driers, as required.

The Model 300-F moisture detector (right), introduced in 1955, is designed to handle any weight of paper from 0.0003 in. to the heaviest board. A numbered dial permits setting of any desired sensitivity.

All controls are housed in a central control panel (center) which may be located at any convenient point. A 12-in. recorder-controller with proportional band adjustment records and controls steam pressure to the driers. A second pen records moisture variation of the paper as it passes over the driers. Dials on the panel show pressure steam supply header, pressure return header, temperature of steam, output from moisture detector, output from pressure control, air pressure output to diaphragm motor valve, instrument supply air pressure, mill supply air pressure, and pressure to air loader of moisture detector.

Panel controls are for instrument supply pressure; moisture detector air loader; routing valve for automatic moisture, automatic pressure and open-closed settings; and routing valve for single-dual control. Red and green lights indicate wet end breaks. A photoelectric eye detects breaks in the paper and automatically shifts the system from automatic



Diaphragm motor valve *Control panel* *Moisture Detector*

Chemical Pulping Processes

Chemipulp and Chemipulp-KC systems help achieve maximum production of uniform, high quality pulp at lower cost and provide means for efficient recovery of heat and chemicals:

- Hot Acid Systems
- Independent Recovery Systems
- Recovery Towers
- Digester Circulating Systems
- Chip Distributors
- Jet-Type Sulphur Burners
- Spray-Type SO_2 Gas Cooling Systems
- Sulphite Acid Systems
- Neutral Sulphite Semi-Chemical Liquor Plants
- Hydroheaters
- Black Liquor Oxidation Systems for Sulphate Pulp Mills

Chemipulp Process Inc.
Watertown, N. Y.

Associated with

Chemipulp Process Ltd., 253 Ontario St., Kingston, Ont.

•

Pacific Coast Representative

A. A. Lundberg Inc., P.O. Box 186, Mercer Island, Wash.

moisture control to automatic pressure control. Then, pressure is maintained at a preset level until the sheet is brought back over the machine, at which time control shifts back to automatic.

The Stickle diaphragm motor valve (left) is engineered to fit the individual steam requirements of each machine. A travel indicator shows the position of the valve at a glance.

The Stickle system is backed by a 60-day unconditional guarantee. If not satisfactory at the end of this period, it may be returned for full credit. When installed according to directions, the system is guaranteed "to automatically control the makeup of steam to the machine or the release of exhaust steam to meet the variations or changes in free to hard drying stock, or changes in weights that occur, and to maintain any given percentage of moisture required for finish not to exceed a variation of 0.5%.

EMPLOYMENT SERVICE

The rates per issue for Positions Open advertisements in *Tappi* are as follows:

Per line	$ 3
1/16-page Box	$ 50
1/8-page Box	$ 80
1/4-page Box	$125

Positions Wanted

E540-61. Sales engineer, stock preparation equipment. Foreign and domestic applications.

E541-61. Situation wanted by paper technologist, specializing in the study of the permanence and durability of paper. Has had many years of experience in the manufacture and the evaluation by chemical and physical means of fine papers for permanent records.

E542-61. Chemical Engineer, presently employed, M.S. in chemical engineering. Twelve years experience in the manufacture of boxboard and corrugating medium, 10 years as department head of a production lab. Experienced in technical development, quality control, and carton converting. Desires responsible position in technical or production management. Résumé and references upon request.

E543-61. Quality Control or Technical Director available. College graduate with 20 years experience in all phases of technical, quality, and production control in the manufacture of linerboard, corrugating medium, and corrugated boxes. Résumé and references upon request.

Positions Open

P2009-61. Man with background in paper mills or corrugated container plants to sell starches, dextrines, and related materials.

P2030-61. WANTED: Technical Superintendent for a 375 ton per day kraft linerboard mill. Must have several years technical experience in all phases of kraft pulp and paper manufacturing, with organizational and leadership abilities. Send complete résumé including personal data, educational, and employment history to: Mr. Hugo Trygg, Mill Manager, Boise Cascade Corp., P. O. Box 500, Wallula, Wash.

We are growing and need additional men for combined sales and technical service work in the United States and Canada. If you have college or graduate training in a biological science (preferably bacteriology or mycology) and are either selling to or working in the paper industry, we would welcome the opportunity to tell you more about us and our work. We have an orientation and training program, compensation after training based on salary plus commission, Blue Cross, group life insurance, a profit-sharing annuity retirement plan, plus your personal opportunity to grow with us.

Contact Mr. W. D. Stitt
BUCKMAN LABORATORIES, INC.
Memphis 8, Tennessee

(P2015-61)

GENERAL MANAGER

A General Manager is required by SICAR S.p.A. to take full charge of paper, board and packaging interests in Italy, which it is intended to expand by 1964 to a total investment of more than 20 milliard lire.

SICAR is a partnership between La Centrale Finanziaria of Milan and the Reed Paper Group of London whose technical skills are fully available to the company.

The appointment demands a man of proved ability with several years experience in General Management with particular emphasis on the financial and commercial control of a manufacturing and marketing business. Experience in the paper and packaging industry would be an advantage, but would not be essential for the man who is capable of mastering quickly the technical aspects of the business. A good knowledge of the Italian language is essential.

Please address application to **P2031-61, Tappi, 360 Lexington Ave., New York 17, N. Y.**

ASSISTANT SUPERINTENDENT

Multiplant pulp and paper company has opening offering excellent opportunity for an Assistant Superintendent in the field of coated bleached heavy weight board in large modern plant located in the Southern region. Duties will include responsibility for the supervision of board-making operations including production, quality and cost control. We are seeking a man experienced in this field who has potential to move up in management.

Please send résumé of experience, education and salary requirements to **P2032-61, Tappi, 360 Lexington Ave., New York 17, N. Y.**

WANTED: UNIVERSITY GRADUATES RESEARCH & DEVELOPMENT

PRICE BROTHERS & COMPANY, LIMITED, RESEARCH DEPARTMENT, has a number of interesting positions open.

A varied field for research is assured as production includes: newsprint; groundwood, sulphite and kraft pulps; folding box board, etc.

Applicants should have a technical degree in Science, Engineering Physics, Chemical Engineering, or pulp and paper technology. Industrial experience preferred, but not essential. Post-graduate work a definite asset.

Good starting salaries and fringe benefits.

LOCATION: Well developed bilingual community in Northeastern Quebec.

In confidence, please send résumé and salary requirements to:

PRICE BROTHERS & COMPANY, LIMITED
ATT'N: SUPERINTENDENT—PERSONNEL & LABOUR RELATIONS, KENOGAMI, P.Q. **(P2035-60)**

CHEMISTS - PAPER CHEMISTS CHEMICAL ENGINEERS

One of the nation's leading manufacturers of paper and paper products has openings in its research laboratories for COATING SPECIALISTS to work on projects in the areas of applied research, mill problems and new products.

Prefer a Ph.D. or M.S. degree in chemistry, chemical engineering or pulp and paper technology with 2–6 years experience. However, other backgrounds may be considered.

Openings also available for PAPER TECHNOLOGISTS to work on new product development in the technical papers area.

Prefer a B.S. degree in chemical engineering with 2–4 years experience in paper manufacturing.

Qualified candidates should send a complete résumé of educational background and experience to:

G. H. MEILINGER
EMPLOYMENT SUPERVISOR
THE MEAD CORPORATION
CHILLICOTHE, OHIO

All replies will receive immediate and confidential attention.

(P2033-61)

ATTRACTIVE OPPORTUNITIES

FOR

PAPER COLORIST and **PAPER TECHNOLOGIST**

REQUIREMENTS INCLUDE: Experience in paper pulping, beating, dyeing and color matching.

POSITION INCLUDES: Some travel as technical service advisor in customer's mills.

Excellent opportunity for advancement, all benefits, generous salary. Send résumé in confidence to:

PERSONNEL DEPARTMENT
NATIONAL ANILINE DIVISION
ALLIED CHEMICAL CORPORATION
1051 South Park Avenue
Buffalo 10, New York

an equal opportunity employer

(P2036-61)

Project-Process Engineers

Our tremendous growth and planned for expansion has created openings for Project and Process Engineers.

Qualifications:

B.S. or M.S. in Chemical, Mechanical or Electrical Engineering. 5–15 years of experience, preferably in plastics processing field. Must have proven record of imagination and initiative.

Position Description:

Assignments in the initial production plant (Semi-Works) for polypropylene films. Process and project assignments will be in process debugging, production cost reduction, design of equipment improvements, installation of new equipment and equipment modifications, maintenance problems, and assisting in training production personnel. Operation includes: extrusion or orientation of films, coating, winding, and slitting films, bag making and printing.

Growth Opportunities:

Process and Project Engineering assignments in headquarters plant or branch plants leading to engineering management or production management. Also excellent possibility for start-up assignments in overseas plants.

Send detailed résumé to:

C. W. Russell
Management Development Assistant
Kordite Company
Macedon, New York

All replies confidential.

(P2034-61)

Acidproof Brick Chemical and Physical Properties

Technical Information Sheet No. 3

THE brick used for chemical-resistant masonry construction are of three main types fireclay, red shale, and carbon. Clay and shale brick have excellent resistance to all solutions of acids and salts except hydrofluoric acid and related acids and salts. Carbon and graphite brick have excellent resistance to practically all solutions of acids, salts, and alkalies except that there are limitations in cases where strong oxidizing agents are present.

The general ranges of the physical properties for these types of brick are as follows:

ASTM test number	*Property*	*Fireclay*	*Shale*	*Carbon*	*Graphite*
C-67-57	Compressive strength, p.s.i.	12,000–18,000	12,000–20,000	6500–10,000	3000–5000
	Tensile strength, p.s.i.	700–1400	500–1000	900–1200	600–1000
C-67-57	Modulus of rupture, p.s.i.	2000–3600	1800–3500	1500–3000	1200–2000
C-20-46[a]	Water absorption 5 hr. boil, %	1.0–6.0	0.5–4.0	10–15	15–20
C-20-46[a]	Apparent porosity, %	2.0–14.0	1.0–10.0	18–25	25–30
C-20-46[a]	Bulk density, g./cc.	2.1–2.3	2.1–2.3	1.55	1.56
	Weight, lb./cu. ft.	130–150	135–150	100	100
	Modulus of elasticity, p.s.i. $\times 10^6$	5.0–8.0	6.0–10.0	1.7	1.35
	Coefficient of linear thermal expansion in./in.°F. $\times 10^{-6}$	2.5–3.5	2.4–3.0	1.5	1.0
	Thermal conductivity, B.t.u./(hr.) (sq. ft.) (°F./ft.)	0.45–0.65	0.6–0.8	3.0	86.0

[a] Test modified to provide 5 hr. boil time instead of 2 hr. as required by ASTM C-20-46.

Prepared by: B. Thomas for Corrosion Committee (C.A. 660).

Reference: American Society for Testing Materials, "ASTM Standards 1958, Parts 4 and 5" for standard tests listed in above data Also, see ASTM standard specification No. C-279-54 entitled, "Chemical Resistant Masonry Units" in Part 5 of this same text.

Physical and Mechanical Properties of Mortars for Chemical Resistant Masonry Construction

Technical Information Sheet No. 4

THE mortars used in joining acidproof brick and tile for chemical resistant masonry construction are of three main types—silicate, sulfur, and resin. Silicate, sulfur, and resinous materials are used as binders with inert fillers, usually silica or carbon, to make chemical resistant mortars.

The following are physical and mechanical properties of typical mortars for chemical resistant masonry construction:

ASTM test number	*Property*	*Silicate (silica filled)*	*Sulfur (silica filled)*	*Phenolic resin (silica filled)*	*Furan resin (carbon filled)*	*Polyester resin (silica filled)*	*Epoxy resin (carbon filled)*
	Weight, lb./cu. ft.	125	138	118	95	128	95–115
C-413-58T	Apparent porosity, %	Over 12	Less than 1	0.5–2.0	Less than 1	Less than 1	Less than 1
C-307-55	Tensile strength, p.s.i.	350	650	1200	1200	1200	1500
C-287-54							
C-306-60	Compressive strength, p.s.i.	4000	6000	10,000	12,000	12,000	17,500
C-287-54							
	Modulus of elasticity, p.s.i. $\times 10^6$	1.0	1.2	0.6	0.8	1.5	1.3
	Coefficient of linear thermal expansion, in./in.°F. $\times 10^{-6}$	6.0	18.2	8.4	11.5	38.0	30.0
	Maximum service temperature, °F.	750–1600	190	350	375	250	250
C-308-55	Working time, min. at 70°F.	40	...	120	40	60	45
C-414-58T							
C-308-55	Final setting, time, days	3	...	6	2	2	2
C-414-58T							

Prepared by: B. Thomas for Corrosion Committee (C.A. 661).

Reference: American Society for Testing Materials, "ASTM Standards 1958, Parts 4, 5, and 9."

Chemical Resistance of Typical Mortars for Corrosion Resistant Masonry Construction

Technical Information Sheet No. 5

THE chemical resistance of these typical mortars is, generally speaking, the same for both of the two commonly used filler materials, silica and carbon. The one exception is that silica cannot be used in the presence of strong alkaline materials or fluorine containing acids or salts. Otherwise, the filler material may be selected on the basis of electrical properties, color, mortar working characteristics, physical properties, and cost.

R = Generally recommended. LR = Limited recommendation (test before using). NR = Generally not recommended.

	Silicate[a]		*Sulfur*[b]		*Phenolic resin*		*Furan resin*		*Polyester resin*		*Epoxy resin*	
	75°F.	*200°F.*	*75°F.*	*150°F.*	*75°F.*	*200°F.*	*75°F.*	*200°F.*	*75°F.*	*200°F.*	*75°F.*	*200°F.*
Acids												
Acetic, dilute	R	R	R	R	R	R	R	R	R	LR	R	R
Acetic, glacial	R	R	LR	NR	R	LR	R	R	NR	NR	LR	NR
Chromic	R	R	LR	LR	NR	NR	NR	NR	R	LR	LR	NR
Citric	R	R	R	R	R	R	R	R	R	R	R	R
Fatty acids	R	R	LR	LR	R	R	R	R	LR	LR	LR	LR
Formic	R	R	LR	NR	R	R	R	R	LR	NR	LR	LR
Hydrobromic	R	R	R	R	R	R	R	R	R	R	R	R
Hydrochloric	R	R	R	R	R	R	R	R	R	R	R	R
Hydrofluoric	NR	NR	R[c]	R[c]	R[c]	R[c]	R[c]	R[c]	LR	NR	R[c]	R[c]
Hypochlorous	R	R	NR	NR	LR	NR	NR	NR	R	LR	NR	NR
Lactic	R	R	R	R	R	R	R	R	R	R	R	R
Nitric	R	R	R	LR	NR	NR	NR	NR	LR	NR	NR	NR
Oleic	R	R	R	LR	R	R	R	R	R	LR	R	R
Phosphoric	R	R	R	R	R	R	R	R	R	R	R	R
Sulfite pulp cooking acids	R	R	R	LR	R	R	R	R	R	LR	R	R
Sulfuric 50%	R	R	R	R	R	R	R	R	R	R	R	R
Sulfuric 80%	R	R	R	LR	R	LR	R	LR	LR	NR	LR	NR
Sulfuric, conc.	R	R	LR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sulfurous	R	R	R	R	R	R	R	R	R	R	R	R
Alkalies												
Ammonium hydroxide	NR	NR	NR	NR	NR	NR	R	R	NR[d]	NR[d]	R	LR
Alkaline pulp cooking liquors	NR	NR	NR	NR	NR	NR	R	LR	NR[d]	NR[d]	R	LR
Calcium hydroxide	NR	NR	NR	NR	LR	NR	R	R	NR[d]	NR[d]	R	R
Milk of lime	NR	NR	NR	NR	LR	NR	R	R	NR[d]	NR[d]	R	R
Soaps	NR	NR	LR	LR	LR	LR	R	R	LR[d]	LR[d]	R	R
Sodium hydroxide 1%	NR	NR	NR	NR	NR	NR	R[c]	R[c]	NR[d]	NR[d]	R	R
Sodium hydroxide 10%	NR	NR	NR	NR	NR	NR	R[c]	LR[c]	NR[d]	NR	R	LR
Sodium hydroxide 25%	NR	NR	NR	NR	NR	NR	R[c]	LR[c]	NR[d]	NR[d]	R	LR
Gases												
Chlorine, dry	R	R	NR	NR	LR	NR	LR	NR	LR	LR	NR	NR
Chlorine, wet	LR	LR	NR	NR	LR	NR	LR	NR	LR	LR	NR	NR
Chlorine dioxide	R	R	NR	NR	NR	NR	NR	NR	R	LR	NR	NR
Hydrogen sulfide	R	R	R	R	R	R	R	R	R	R	R	R
Steam	...	NR	...	...	...	R	...	R	...	R	...	R
Sulfur dioxide	R	R	R	R	R	R	R	R	R	R	R	R
Bleach Solutions												
Chlorine water	LR	LR	NR	NR	LR	NR	LR	NR	R	LR	NR	NR
Chloride of lime	NR	NR	NR	NR	LR	NR	LR	LR	LR	LR	LR	LR
Chlorine dioxide	LR	LR	NR	NR	NR	NR	NR	NR	R	LR	NR	NR
Per-acids	LR	LR	LR	NR	LR	LR	LR	LR	LR	LR	LR	LR
Peroxide solutions	LR	LR	LR	NR	LR	LR	R	LR	LR	LR	LR	LR
Potassium permanganate	R	R	LR	LR	R	R	R	R	R	R	R	R
Sodium chlorite (alkaline)	NR	NR	NR	NR	NR	NR	R	LR	LR	LR	LR	LR
Sodium hydrosulfite	NR	NR	NR	NR	NR	NR	R	R	LR	LR	R	LR
Sodium hypochlorite	NR	NR	NR	NR	NR	NR	LR	LR	R	LR	LR	LR
Sodium perborate	NR	NR	NR	NR	NR	NR	R	R	LR	LR	R	LR
Zinc hydrosulfite	NR	NR	NR	NR	NR	NR	R	R	LR	LR	R	LR

(*Sheet No. 5 continued on page 134 A*)

Chemical Resistance of Typical Mortars for Corrosion Resistant Masonry Construction

Technical Information Sheet No. 5—Continued

	Silicate[a]		*Sulfur*[b]		*Phenolic resin*		*Furan resin*		*Polyester resin*		*Epoxy resin*	
	75°F.	*200°F.*	*75°F.*	*150°F.*	*75°F.*	*200°F.*	*75°F.*	*200°F.*	*75°F.*	*200°F.*	*75°F.*	*200°F.*
Salt Solutions												
Alum	R	R	R	R	R	R	R	R	R	R	R	R
Ammonium bisulfite	R	R	R	R	R	R	R	R	R	R	R	R
Ammonium chloride	R	R	R	R	R	R	R	R	R	R	R	R
Ammonium sulfate	R	R	R	R	R	R	R	R	R	R	R	R
Ammonium sulfite	R	R	R	R	R	R	R	R	R	R	R	R
Calcium bisulfite	R	R	R	R	R	R	R	R	R	R	R	R
Calcium chloride	R	R	R	R	R	R	R	R	R	R	R	R
Copper sulfate	R	R	R	R	R	R	R	R	R	R	R	R
Ferric salts	R	R	R	R	R	R	R	R	R	R	R	R
Ferrous salts	R	R	R	R	R	R	R	R	R	R	R	R
Magnesium bisulfite	R	R	R	R	R	R	R	R	R	R	R	R
Magnesium sulfate	R	R	R	R	R	R	R	R	R	R	R	R
Magnesium sulfite	R	R	R	R	R	R	R	R	R	R	R	R
Sodium bicarbonate	NR	NR	R	LR	R	R	R	R	R	R	R	R
Sodium bisulfite	R	R	R	R	R	R	R	R	R	R	R	R
Sodium carbonate	NR	NR	LR	NR	LR	NR	R	R	LR	LR	R	R
Sodium chloride	R	R	R	R	R	R	R	R	R	R	R	R
Sodium silicate	LR	NR	LR	LR	LR	LR	R	R	LR	LR	R	R
Sodium sulfate	R	R	R	R	R	R	R	R	R	R	R	R
Sodium sulfide	NR	NR	NR	NR	NR	NR	R	R	NR[d]	NR[d]	R	R
Sodium sulfite	NR	NR	LR	NR	LR	NR	R	R	LR[d]	NR[d]	R	R
Sodium thiosulfate	LR	NR	R	LR	R	LR	R	R	R	LR[d]	R	R
Trisodium phosphate	NR	NR	NR	NR	LR	NR	R	R	LR[d]	NR[d]	R	R
Organic Materials												
Acetone	R	R	NR	NR	LR	NR	R	R	LR	NR	R	LR
Alcohols	R	R	R	R	LR	LR	R	R	R	R	R	R
Aniline	LR	NR	NR	NR	NR	NR	LR	NR	NR	NR	LR	NR
Animal oils	R	R	LR	LR	R	R	R	R	LR	LR	R	R
Benzene	R	R	NR	NR	R	R	R	R	LR	NR	R	LR
Carbon tetrachloride	R	R	NR	NR	LR	LR	R	R	LR	NR	R	LR
Chloroform	R	R	NR	NR	R	R	R	R	LR	NR	R	LR
Ethyl acetate	R	R	NR	NR	R	LR	R	R	NR	NR	R	LR
Ethylene dichloride	R	R	NR	NR	R	R	R	R	NR	NR	R	LR
Formaldehyde 37%	R	R	R	R	R	R	R	R	R	R	R	R
Mineral oils	R	R	LR	NR	R	R	R	R	LR	LR	R	R
Tall oil	R	R	LR	LR	R	R	R	R	LR	LR	R	LR
Toluene	R	R	NR	NR	R	R	R	R	LR	NR	R	LR
Vegetable oils	R	R	LR	LR	R	R	R	R	LR	LR	R	R

[a] Silicate of soda cements have good resistance to acid solutions of high concentration, but only fair resistance to hot dilute solutions.
[b] Temperature limit for use, 190°F.
[c] Carbon filler.
[d] Special types of polyester cements have good resistance to alkaline solutions.

Prepared by: B. Thomas for Corrosion Committee (C.A. 662).

Power Requirements of Feltless Pulp Machines

Technical Information Sheet No. 6

PURPOSE

The purpose of this Technical Information Sheet is to provide guidance in the selection of drive power for feltless pulp machines.

DEFINITION OF TERMS

Power Constants

Power constants for paper machine drives are commonly expressed in horsepower per inch of machine width per 100 f.p.m. of speed, and abbreviated as hp./in./100 f.p.m. Width is taken as the cylinder mold width, and speed as the top operating speed. The power constants have been established for each machine section. One is the normal running load (NRL), the other, the recommended drive capacity (RDC).

Normal Running Load (NRL)

NRL is the expected running load on each section of the machine when operated under normal conditions. This includes such items as normal vacuum conditions on the mold; normal nip pressures; proper bearing alignment; and adequate lubrication. Thus the estimate of the total normal running load of any feltless pulp machine becomes the sum of the NRL constants for the various machine sections.

The power constant table for feltless pulp machines shows three values for NRL; minimum, average, and maximum. The maximum and minimum columns show the range of loads that were observed among the various machines studied; the average column is the arithmetic average of the load readings observed.

Recommended Drive Capacity (RDC)

RDC represents the power requirement estimated for a particular section when operated at maximum anticipated load. These maximum loads may result from high nip pressures, misalignment, and many other conditions. The difference between RDC and NRL represents the operating safety margin above NRL. It is to be recognized that the RDC is not large enough to satisfy all abnormal conditions, but should be sufficient for normal practices.

Section	*NRL* Constant	*NRL* Hp.	*RDC* Constant	*RDC* Hp.	*Minimum motor selected, hp*
Cylinder mold	0.071	10.7	0.12	18	20[a]
First press	0.188	28.2	0.30	45	50
Pre-drier	0.008	1.2	0.03	4.5	5
Second press	0.256	38.4	0.35	52.5	60[b]
Entry pull roll	...	...	0.02	3	3
Each conveyor	0.009	1.35	0.02	3	3
Total conveyor	0.081		...	...	
Exit pull roll	...		0.02	3	3
Cutter	0.033	4.95	0.06	9	10
	0.637				

Generator: $\frac{0.637 \times 150}{0.91} = 105$ (use 100 kw.)

[a] Consider 20 hp. to duplicate mold.
[b] Consider 60 hp. to duplicate 2nd press.

Prepared by: Electrical Engineering Committee (C.A. 620).

Power Requirements for Feltless Pulp Machines

Section	*Horsepower per inch width per 100 f.p.m.* NRL[a] *Minimum*	*Average*	*Maximum*	*RDC*[b]
Cylinder mold				
With three pressure rolls	0.044	0.071	0.106	0.12
With four pressure rolls	...	...	0.134	0.15
Presses				
Up to 1800 lb./in. pressure	0.136	0.188	0.32	0.30[c]
Above 1800 lb./in. pressure	0.186	0.256	0.36	0.35[c]
Pre-driers				
(Two 60 in. rolls)	0.003	0.008	0.014	0.03
(Two 48 in. rolls)	0.0014	0.004	0.005	0.03
Pull rolls (for conveyor drier)	...	...	..	0.02[d]
Conveyor drier (nine conveyors)				
Single motor	0.023	0.034	0.04	0.06
Multiple motors (nine motors) each	0.004	0.009	0.019	0.02
Cutters	0.026	0.033	0.05	0.06

[a] NRL is normal running load.
[b] RDC is recommended drive constant.
[c] The RDC for presses to be considered as a minimum value.
[d] If separately driven.

Use of NRL and RDC

It is recommended that NRL and RDC constants be used as follows:

1. Use NRL for selecting:
   (a) Power supply generator for a single generator type electric drive-with proper allowance for section motor losses. Use total average NRL as kilowatts per inch width per 100 f.p.m. for selecting generator.
   (b) Prime movers for generator sets on electric drives with proper allowance for losses in the direct current motors and generators.
2. Use RDC for selecting:
   (a) Gearing, with appropriate service factors.
   (b) Section drive motors.

Example of Use

Pulp Machine:

Product-kraft pulp	350 lb./100 sq. ft.
Width	150 in.
Speed	30 to 100 f.p.m.
Cylinder mold	96 in. diam.—20 in. vacuum three pressure rolls
First press	1800 lb./in. width max. pressure
Pre-drier	two 60-in. rolls
Second press	3000 lb./in. max. pressure
Conveyor drier	nine conveyors each separately driven
Entry pull roll	separately driven
Exit pull roll	separately driven
Cutter	separately driven
Machine constant, in. width × f.p.m./100	(150 × 100)/100 = 150

TAPPI Fibrary. Addendum V

This catalog is an addendum to the third edition of the TAPPI Fibrary, for which collection efforts were initiated in October, 1949. (See 1960–61 TAPPI Yearbook, p. 105.) Although 510 samples are listed to date there are still many fibers which are needed. It is hoped that contributions of missing species will be forthcoming from TAPPI members so this fiber collection may continue to enlarge and increase in value.

A representative specimen of each fiber may be obtained from the Fibrary, The Institute of Paper Chemistry, Appleton, Wis. Each sample has a number which may be used in ordering. A service charge of 50 cents ($0.50)* per sample has been established to help defray the cost of handling, packing, and postage. Remittance of the necessary fee at the time of ordering will help to keep these costs as low as possible.

* Because of rising costs during the decade the TAPPI Fibrary has been in operation, it has been necessary to increase this handling charge to 50 cents with the publication of this addendum.

The custodians of the Fibrary have checked, to the best of their ability, all fibers submitted, as to species and process. Please write them if any error is detected.

The amount of pulping data given by the donor varies considerably in different samples. Because of space limitations many of the details which have been sent with the sample will not be published but will be filed with the sample for reference purposes. Naturally, it is desirable to have complete details, if available.

No acknowledgment has been made in the catalog to the donors for the various samples. In many instances several companies or individuals offered the same fibers and while duplication is inevitable, every effort was made to avoid it to conserve space without decreasing the effectiveness of the fiber collection. Unquestionably, the gratitude of the industry is due these anonymous donors.

No.	*Species*	*Location grown*	*Process*	*Degree of cooking*	*Bleaching*	*Remarks*
466	Abaca (*Musa textilis*)	Philippine Islands	Soda		None	
467	Alder, red (*Alnus rubra*)	California	Sulfite	Soft	Full	Peroxide bleached
468	Ash, white (*Fraxinus americana*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
469	Aspen (*Populus tremuloides*)	Michigan	Cold soda	High yield	None	350 C.S. freeness
470	Aspen (*Populus tremuloides*)	Michigan	Cold soda	High yield	Full	350 C.S. freeness Peroxide bleached
471	Beech (*Fagus grandifolia*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
472	Birch, yellow (*Betula lutea*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
473	Caroa fiber (*Neoglaziovia variegata*)	Brazil	Soda		None	
474	Cherry, black (*Prunus serotina*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
475	Elm, American (*Ulmus americana*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
476	Elm, American (*Ulmus americana*)	New York	Cold soda	High yield	None	
477	Elm, American (*Ulmus americana*)	New York	Cold soda	High yield	Full	Peroxide bleached
478	Hackberry (*Celtis occidentalis*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
479	Lemon grass (*Cymbopogon citratus*)	Guatemala	Lime	High yield	None	25% SW kraft
480	Maple, red (*Acer rubrum*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
481	Maple, silver (*Acer saccharinum*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
482	Oak, blackjack (*Quercus marilandica*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
483	Oak, blue (*Quercus douglasii*)	California	Neutral sulfite semichemical	Intermediate yield	None	
484	Oak, California black (*Quercus kelloggii*)	California	Neutral sulfite semichemical	Intermediate yield	None	
485	Oak, California white (*Quercus lobata*)	California	Neutral sulfite semichemical	Low yield	None	
486	Oak, chestnut (*Quercus prinus*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
487	Oak, northern red (*Quercus rubra*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
488	Oak, northern red (*Quercus rubra*)	New York	Cold soda	High yield	None	
489	Oak, northern red (*Quercus rubra*)	New York	Cold soda	High yield	Full	Peroxide bleached
490	Oak, post (*Quercus stellata*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
491	Oak, water (*Quercus nigra*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
492	Oak, white (*Quercus alba*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
493	Oak, white (*Quercus alba*)	New York	Cold soda	High yield	None	
494	Oak, white (*Quercus alba*)	New York	Cold soda	High yield	Full	Peroxide bleached
495	Oat straw (*Avena sativa*)	Holland	Neutral sulfite semichemical	Low yield	None	
496	Palmetto, cabbage (*Sabal palmetto*)	Florida	Kraft		None	
497	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Neutral sulfite	Medium	None	
498	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Sivola	Medium	Full	
499	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Magnefite	Medium	None	
500	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Magnefite	Medium	Full	
501	Redwood (*Sequoia sempervirens*)	California	Nitric acid		None	
502	Rye straw (*Secale cereale*)	Holland	Neutral sulfite semichemical	Low yield	None	
503	Sourwood (*Oxydendron arboreum*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
504	Sweetgum (*Liquidambar styraciflua*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
505	Sycamore (*Platanus occidentalis*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
506	Tan-oak (*Lithocarpus densiflorus*)	California	Neutral sulfite semichemical	Medium yield	None	
507	Tupelo, black (*Nyssa sylvatica*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
508	Willow, black (*Salix nigra*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
509	Yellow-poplar (*Liriodendron tulipifera*)	Tennessee	Cold soda	High yield	None	100 C.S. freeness
510	Yucca (*Yucca* sp.)	Mexico	Nitric acid		None	

LOCAL SECTION ACTIVITIES

Officers and Executive Committees

Chicago Section (Chartered in 1943)

Chairman—William D. Kenney, Weyerhaeuser Co., 5800 W. 57 St., Chicago 38, Ill.
First Vice-Chairman—Paul M. Gronendyke, National Starch & Chemical Corp., 3641 S. Washtenaw Ave., Chicago 32, Ill.
Second Vice-Chairman—Roy P. Caponi, Union Bag-Camp Paper Corp., 4545 W. Palmer St., Chicago 39, Ill.
Third Vice-Chairman—Mike Hecht, Chicago Carton Co., 4200 So. Pulaski Road, Chicago 32, Ill.
Secretary—Albert J. Miller, Container Corp. of America, 10 N. Clark St., Chicago 3, Ill.
Treasurer—Alex. Glassman, R. R. Donnelley & Sons Co., 350 E. Cermak Rd., Chicago 16, Ill.
Executive Committee—Officers and Edward C. Berg, Weyerhaeuser Co., Chicago, Ill.; William D. Hall, Folding Paper Box Association of America, Chicago, Ill.; Carl M. Helm, American Cyanamid Co., Chicago, Ill., Warren R. Price, Consultant, Skokie, Ill.; Melvin W. Snover, Hollingsworth & Vose Co., Chicago, Ill.; and Henry J. Klauke, Ekco-Alcoa Containers, Wheeling, Ill.

Delaware Valley Section (Chartered in 1931)

Chairman—C. A. Wynn, Container Corp. of America, Manayunk, Philadelphia, Pa.
First Vice-Chairman—Henry L. Smaine, P. H. Glatfelter Co., Spring Grove, Pa.
Second Vice-Chairman—Philip A. Cerasoli, Hamilton Paper Co., Miquon, Pa.
Secretary—Peter N. Yiannos, Scott Paper Co., Chester, Pa.
Treasurer—Donald S. Blair, Monsanto Chemical Co., Mail: 448 Anthony Road, King of Prussia, Pa.
Executive Committee—Officers and Alfred L. Saindon, Curtis Paper Co., Newark, Del., and C. F. Ackerman, Union Mills Paper Mfg. Co., New Hope, Pa.

Empire State Section (Chartered in 1938)

Chairman—James J. Forsythe, International Paper Co., Niagara Falls, N. Y.
First Vice-Chairman—Earl H. Johnson, Stevens & Thompson Paper Co., Greenwich, N. Y.
Second Vice-Chairman—Paul R. Anderson, St. Regis Paper Co., Deferiet, N. Y.
Third Vice-Chairman—Allen F. Holmes, Sealright-Oswego Falls Corp., Fulton, N. Y.
Secretary—C. B. Blanchard, Buffalo Rubber & Supply Co., Mail: 195 Hathaway Road, Syracuse 14, N. Y.
Treasurer—J. U. Wolff, Nopco Chemical Co., Mail: 219 Ridge St., Glens Falls, N. Y.
Executive Committee—Officers, District Chairmen and William R. Willets, Titanium Pigment Co., New York, N. Y.; Horace A. Spencer, Knowlton Bros., Watertown, N. Y.; J. Wayne Morrow, Newton Falls, Paper Co., Newton Falls, N. Y.; and John C. Rice, Lowe Paper Co., Ridgefield, N. J.

Central District

Chairman—Frank W. Lorey, College of Forestry, State University of New York, Syracuse, N. Y.
Vice-Chairman—Lawrence J. Slentz, Solvay Process Div. Allied Chemical Co., Solvay, N. Y.
Secretary—Marie M. Martin, Sealright-Oswego Falls Corp., Fulton, N. Y.
Treasurer—Frank C. Smith, Huyck Felt Co., Rensselaer, N. Y.

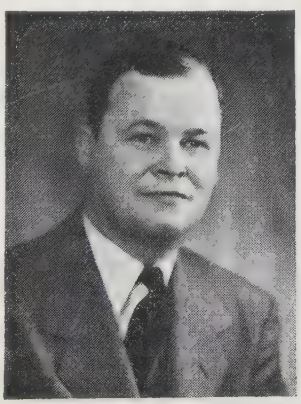
Eastern District

Chairman—Gordon B. Rabeler, International Paper Co., South Glens Falls, N. Y.
Vice-Chairman—Warren Lemke, International Paper Co., South Glens Falls, N. Y.
Secretary—Guenter Herwig, Finch, Pruyn & Co., Glens Falls, N. Y.
Treasurer—William Montgomery, Finch, Pruyn & Co., Glens Falls, N. Y.

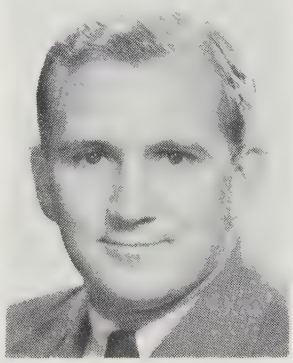
Metropolitan District

Chairman—Gordon C. Inskeep, St. Regis Paper Co., New York, N. Y. (Mail: 144 Nelson Rd., Scarsdale, N. Y.)
Vice-Chairman—Alfred M. Hartley, Jr., Nopco Chemical Co., 60 Park Place, Newark 1, N. J.
Secretary—Con. C. Carrano, James Carrano & Sons, Inc., 563 Water St., New York 2, N. Y.

C. A. Wynn, Container Corp. of America; Delaware Valley

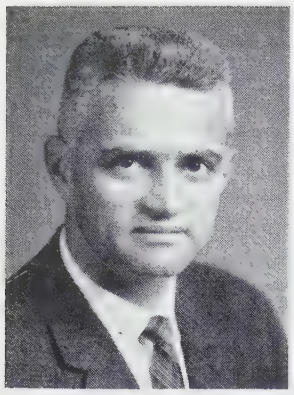


J. J. Forsythe, International Paper Co.; Empire State



F. W. Lorey, State University of New York College of Forestry; Central District

G. B. Rabeler, International Paper Co.; Eastern District



Gordon C. Inskeep, St. Regis Paper Co.; Metropolitan District

H. L. Rammer, Fibreboard Paper Products, Inc.; Golden Gate

Treasurer—Milton D. Schreiber, Keuffel & Esser Co., Hoboken, N. J.

Northern District

Chairman—Charles H. Manhood, Jr., Carthage, N. Y. (Mail: 1351 Sherman St. Watertown, N. Y.)
Vice-Chairman—Bernard J. Twisdale, Gould Paper Co., Lyons Falls, N. Y.
Secretary—William E. Martin, Stebbins Engineering & Mfg. Co., Watertown, N. Y.
Treasurer—Myron C. Durkee, Knowlton Bros., Co., Watertown, N. Y.

Western District

Chairman—Harry B. Hulse, The Upson Co., Lockport, N. Y.
Vice-Chairman—Charles A. Kremers, Kimberly-Clark Corp., Niagara Falls, N. Y.
Secretary—Nicholas I. Johnson, Socony-Mobil Oil Co., P. O. Box 959, Buffalo, N. Y.
Treasurer—Ward I. Arnold, International Paper Co., North Tonawanda, N. Y.

Golden Gate Section (Chartered in 1960)

Chairman—H. L. Rammer, Fiberboard Paper Products, Inc., Mill No. 2, First and L. St., Antioch, Calif.
Vice-Chairman—Emil Padavic, Container Corp. of America, 2600 de la Cruz Blvd., Santa Clara, Calif.
Secretary-Treasurer—Walter R. Brandt, General Aniline & Film Corp., 206 Utah Ave., So. San Francisco, Calif.
Recording Secretary—L. G. Maclise, Dow Chemical Co., 355 Sansome St., San Francisco, Calif.

William Elsevier, International Paper Co., former chairman; C. M. Ayres, Rust Engineering Co., secretary; D. L. Pollet, Crown Zellerbach Corp. and Mallory Davis, International Paper Co., Executive Committee; Lynn Collins, Container Corp. of America, treasurer; M. T. Still, St. Regis Paper Co., vice-chairman; R. R. Fuller, Gulf States Paper Co., former Executive Committee member; and A. L. Hargraves, St. Joe Paper Co., chairman

Gulf Coast Section (Chartered in 1959)

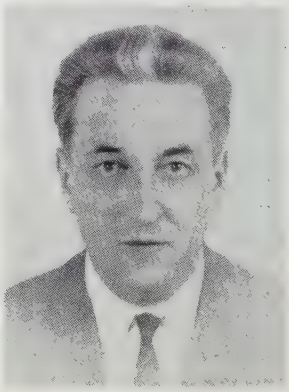
Chairman—A. L. Hargraves, St. Joe Paper Co., Port St. Joe, Fla.
Vice-Chairman—Medie T. Still, St. Regis Paper Co., Pensacola, Fla.
Secretary—C. M. Ayres, Rust Engineering Co., 2316 Fourth Ave. N., Birmingham, Ala.
Treasurer—Lynn Collins, Container Corp. of America, Brewton, Ala.
Executive Committee—Officers and William Elsevier, International Paper Co., Mobile, Ala.; Mallory D. Davis, International Paper Co., Mobile, Ala.; Dalton L. Pollet, Crown Zellerbach Corp., Bogalusa, La.; Vincent F. Waters, Southern Pulp & Paper Manufacturer, Atlanta, Ga.

Italian Section (Sezione Italiana) (Chartered in 1959)

Chairman—Piero Bersano, Cartiere Burgo, Torino
Vice-Chairman—Pietro Ghisoni, Cartiere Vita Mayer & Co., Milano
Vice-Chairman—Leto Ridi, Istituto Poligrafico dello Stato, Rome
Secretary-Treasurer—Alessandro Restagno, Cartiere Burgo, Torino
Executive Committee—Officers and Edoardo Cirla, Cartiera Binda, Milano; Carlo Gregotti, Cartiera di Verona, Milano; and Giuseppe Villa, Cartiera Villa, Milano

Kalamazoo Valley Section (Chartered in 1931)

Chairman—Joseph D. Chadderdon, KVP—Sutherland Paper Co., Kalamazoo, Mich.
Vice-Chairman—Arthur H. Hupp, Watervliet, Mich.
Secretary—Harry Parker, Hodag Chemical Co. (Mail: 1585 Idlewild St., Gull Lake, Rt. 2, Richland, Mich.
Treasurer—Richard H. Glaser, Mac Sim Bar Paper Div., United Biscuit Co., Otsego, Mich.
Executive Committee—Officers and Martin A. Craig, Dow Chemical Co., Midland, Mich.; Thomas E. Flanagan, KVP Sutherland Paper Co., Kalamazoo, Mich.; Charles E. Jakeway, American Box Board Co., Grand Rapids, Mich.; Claude H. Fletcher, Corn Products Sales Co., Kalamazoo, Mich.; Robert M. Levy, Allied Paper Corp., Kalamazoo, Mich.; Vaughn E. Gaddis, Monsanto Chemical Co., Kalamazoo, Mich.; William A. Lunsford, Consolidated Paper Co., Monroe, Mich.; Richard N. Van Buren, J. M. Huber Co., Kalamazoo, Mich.; and James W. Winn, Simpson-Lee Paper Co., Vicksburg, Mich.



Piero Bersano, Cartieri Burgo; Italian

A. L. Hargraves, St. Joe Paper Co.; Gulf Coast

Lake Erie Section (Chartered in 1951)

Chairman—C. Thompson, General Printing Ink Co., 310 Lakeside Ave., Cleveland, Ohio

First Vice-Chairman—A. Prokupek, American Greetings, 11555 Berea Rd., Cleveland, Ohio

Second Vice-Chairman—M. W. West, Container Corp. of America, 6385 Cochran Rd., Solon, Ohio

Secretary—John Young, Borden Chemical Co., 3171 Warrington Ave., Cleveland, Ohio

Treasurer—W. K. Chadwick, Interchemical Corp., 1325 W. 73 St., Cleveland, Ohio

Executive Committee—Officers and H. J. Anderson, Salem Label Co., Salem, Ohio; J. L. Boynton, Fasson Products, Painesville, Ohio; J. Bannon, Decotone Central Corp., Cleveland, Ohio; R. Dyer, Cleveland, Ohio; T. Fitzgerald, General Electric Silicone Products Div., Cleveland, Ohio; D. E. Heindel, General Carton Co., Cleveland, Ohio; P. Miesner, Sr., Hankins Container Co., Cleveland, Ohio; J. Richman, Ace Electrotype Co., Cleveland, Ohio; and J. Zales, Great Lakes Box Co., Div. St. Regis Paper Co., Cleveland, Ohio

Lake States Section (Chartered in 1930)

Chairman—W. I. Stinger, Marathon Div., American Can Co., Manasha, Wis.

Vice-Chairman—John F. Whalen, Combined Locks Paper Co., Combined Locks, Wis.

Secretary—Francis G. Pavlick, Mosinee Paper Mills, Mosinee, Wis.

Treasurer—Kenneth L. Arndt, Peavey Paper Mills, Ladysmith, Wis.

Executive Committee—Officers and Alan P. Adrian, Kimberly-Clark Corp., Neenah, Wis.; Foster P. Doane, Bergstrom Paper Co., Neenah, Wis.; William R. Nelson, Green Bay Paper & Pulp Co., Green Bay, Wis.; S. R. Parsons, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.; William E. Welliver, Minerals & Chemicals Philipp, Appleton, Wis.

Maine-New Hampshire Section (Chartered in 1940)

Chairman—H. Whitney Osgood, S. D. Warren Co., Cumberland Mills, Me.

Vice-Chairman—Lawrence R. Adkins, Waterfalls Tissue Corp., Mechanic Falls, Me.

Secretary-Treasurer—Donald W. Bail, Great Northern Paper Co., Millinocket, Me. (Mail: Cedar St., E. Millinocket, Me.)

Executive Committee—Officers and Andrew J. Chase, University of Maine, Orono, Me.; John C. Cousins, Penobscot Chemical Fibre Co., Great Works, Me.; Carl Perkins, St. Regis Paper Co., Bucksport, Me.; Robert Perry, Scott Paper Co., Waterville, Me.; Edward N. Poor, Hudson Pulp & Paper Co., Augusta, Me.; H. E. Pratt, Pejepscot Paper Div., Brunswick, Mo.; Paul J. Shirley, Jr., Penick & Ford Ltd., Inc., New York, N. Y.; Bartlett A. Taylor, James A. Taylor & Son, Kearsarge, N. H.; Malcolm White, Oxford Paper Co., Rumford, Me.; and Walter J. Wood, National Aniline Div., Boston, Mass.; E. R. Hunting, Fraser Paper, Ltd. Madawaska, Me.

W. I. Stinger, Marathon Div., American Can Co.; Lake States

A. C. Lamoureaux, Dennison Manufacturing Co.; Bay District

New England Section (Chartered in 1933)

Chairman—John W. Wendell, Jr., Tileston & Hollingsworth Co., Hyde Park, Mass.

Secretary—Thomas C. Morganstern, Minerals & Chemicals Phillip, Inc., 7 Sheridan Circle, Wellesley Hills, Mass.

Treasurer—Philip L. Slayton, Monsanto Chemical Co., Boston, Mass. (Mail: 62 Simonds Road, Lexington, Mass.)

Executive Committee—Officers, Chairmen, Secretaries and Treasurers of the Bay District, Berkshire District and Pioneer Valley District and John Lewis, Pulp and Paper Research Center, Inc., Lawrence, Mass.

Bay District (Established in 1957)

Chairman—Albert C. Lamoureux, Dennison Manufacturing Co., Framingham, Mass.

Vice-Chairman—David W. Lovering, Arthur D. Little, Inc. Acorn Park, Cambridge, Mass.

Secretary—L. Paul Crane, Oxford Paper Co., Lawrence, Mass.

Treasurer—William P. Stillman, Bird & Son, Inc., East Walpole, Mass.

Executive Committee—Officers and John W. Wendell, Jr.; Tileston & Hillingsworth Co., Hyde Park, Mass.; John P. Bainbridge, Jr., Penick & Ford Ltd., Bingham, Mass.; Everett D. Cann, Chas. T. Main, Inc., Boston, Mass.; Frank R. Fitz, The Mead Corp., Leominster, Mass.; John Frankevicz, Oxford Paper Co., Lawrence, Mass.; Albert A. Goodrow, Ludlow Papers, Inc., Needham Heights, Mass.; Edmond C. Kelly, Louis Dejonge Co., Fitchburg, Mass.; and John F. Walsh, A. E. Staley Mfg., Co., Danvers, Mass.

Berkshire District (Established in 1960)

Chairman—Milton J. Gordon, Peter J. Schweitzer Div., Kimberly-Clark Corp., Lee, Mass.

Vice-Chairman—William A. Hosmer, Hurlbut Paper Co., So. Lee, Mass.

Secretary—R. M. Henderson, E. D. Jones Corp., Pittsfield, Mass.

Treasurer—A. W. Pinkham, Curtiss-Wright Corp., Stockbridge, Mass.

Executive Committee—Officers and W. F. Atwood, Rising Paper Co., Housatonic, Mass.; Norman Baldiachi, Deerfield Glassine Co., Monroe Bridge, Mass., E. K. Bancroft, Hurlbut Paper Co., So. Lee, Mass. A. B. Daniels, L. L. Brown Paper Co., Adams, Mass.; G. R. Donelson, Brightwater Paper Co., Adams, Mass.; F. C. Hartwell, Peter J. Schweitzer Div., Kimberly-Clark Corp., Lee, Mass.; F. S. Klein, Byron Weston Paper Co., Dalton, Mass.; G. E. Lyman, Peter J. Schweitzer Div., Kimberly-Clark Corp., Lee, Mass.; Quinton Narum, Kimberly-Clark Corp., New Milford, Conn.; and F. L. Simons, Crane & Co., Dalton, Mass.

Pioneer Valley District (Established in 1960)

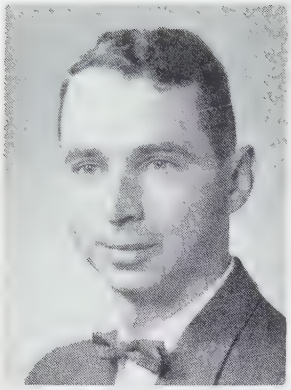
Chairman—Alexander E. Hutton, Jr., Fitchburg Paper Co., Fitchburg, Mass.

Vice-Chairman—David Habib, Tecnifax Corp., Holyoke, Mass.

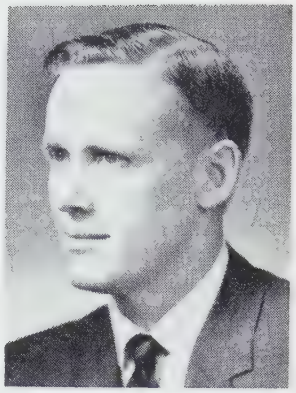
Secretary—Clifford S. Reppe, Hercules Powder Co., Holyoke, Mass.

Treasurer—William F. Nye, Jr., The Hubinger Co., 65 Ohio Ave., W. Springfield, Mass.

Executive Committee—Officers and J. Rex Adams, Old Colony Envelope Co., Westfield, Mass.; James Gallatin,



B. P. Bailey, The Mead Corp.; Ohio



C. S. Walseth, Weyerhaeuser Co.; Pacific

Strathmore Paper Co., W. Springfield Mass.; Burnett Q. Haynes, B. F. Perkins & Sons, Holyoke, Mass.; Robert S. Johnston, Ludlow Paper, Inc., Ware, Mass.; Kenneth E. Leger, Westfield River Paper Co., Russell, Mass.; F. H. Osborne, C. H. Dexter & Sons Co., Windsor Locks, Conn.; E. Whitman Strecker Esleek Mfg., Co., Turners Falls, Mass.; and J. D. Thomson, Northeastern Paper Sales Co., 40 Benedict Terrace, Longmeadow, Mass.

Ohio Section (Chartered in 1935)

Chairman—Burton P. Bailey, Mead Corp., Chillicothe, Ohio
Vice-Chairman—Frank L. Cessna, Sorg Paper Co., Middletown, Ohio
Corresponding Secretary—William F. Aloisi, Diamond National Corp., Middletown, Ohio
Recording Secretary—Raymond E. Essex, Howard Paper Co., Dayton, Ohio
Treasurer—Al. Hart, E. I. du Pont de Nemours & Co., 789 Lovetta Drive, Kettering 29, Ohio
Executive Committee—Officers and C. Edward Brandon, Miami University, Oxford, Ohio; Virgil Perry, Harding-Jones Paper Co., Middletown, Ohio; E. William Petrich, Howard Paper Mills, Inc., Urbana, Ohio; and Charles S. Sweitzer, Diamond National Corp., Lockland, Ohio.

Indiana District (Established in 1957)

Chairman—Charles E. Eberley, Paper Art Co., Inc., 3500 N. Arlington Ave., Indianapolis 18, Ind.
Vice-Chairman (Programs)—Larden V. Hoffman, Container Corp. of America, Wabash, Ind.
Vice-Chairman (Membership)—Cushing B. Roth, Morningstar-Paisley, Inc., 5130 E. 68 St., Indianapolis, Ind.
Secretary—Thomas F. Sullivan, Hartford City Paper Div., Minnesota Mining & Mfg. Corp., P. O. Box 108, Hartford City, Ind.
Treasurer—Frank Sulc, R. R. Donnelley & Sons, Crawfordsville, Ind.
Executive Committee—Officers and W. Doyle Boggess, The Beveridge Paper Co., Indianapolis, Ind.; James P. Casey, Union Starch & Refining Co., Columbus, Ind.; W. B. Lincoln, Jr., Inland Container Co., Indianapolis, Ind.; and Harris O. Ware, The Beveridge Paper Co., Indianapolis, Ind.

Pacific Section (Chartered in 1929)

Chairman—C. S. Walseth, Weyerhaeuser Co., Pulp Div., Everett, Wash.
Vice-Chairman—Lyle J. Gordon, Scott Paper Co., Everett, Wash.
Secretary-Treasurer—Robert H. Smythe, Ray Smythe Co., 511 Park Bldg., Portland, Ore.
Executive Committee—Officers and Douglas B. Armstrong, R. T. Vanderbilt Co., Portland, Ore.; Dwayne J. Clark, Simpson Paper Co., Everett, Wash.; C. W. Davidson, Crown Zellerbach Corp., Camas, Wash.; Porter T. Dickie, Crown Zellerbach Corp., West Linn, Ore.; John M. McEwen, Weyerhaeuser Co., Everett, Wash.

St. Louis Section (Chartered in 1960)

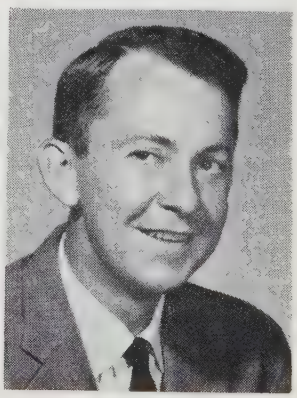
Chairman—William J. Rice, Central States Paper & Bag Co., 5221 Natural Bridge, St. Louis, Mo.
Vice-Chairman—Michael J. Moriarty, Johnston Foil Div., Standard Packaging Corp. 6106 So. Broadway, St. Louis, Mo.
Secretary-Treasurer—B. L. Scallet, Anheuser-Busch, Inc., 721 Pestalozzi St., St. Louis 18, Mo.
Executive Committee—Officers and John C. Braznell, Champion Paper & Fibre Co., St. Louis, Mo.; U. C. Gramsch, Falstaff Brewing Co., St. Louis, Mo.; and James R. Lyon, Alton Box Board Co., Alton, Ill.

Southeastern Section (Chartered in 1952)

Chairman—Robert A. Flick, Brunswick Pulp & Paper Co., Brunswick, Ga.
Vice-Chairman—B. M. Reaves, Sonoco Product Co., Hartsville, S. C.
Recording Secretary—James H. Smith, Continental Can Co., Augusta, Ga. (Mail: 2624 Springwood Drive, Augusta, Ga.
Corresponding Secretary—R. H. Homans, Brunswick Pulp & Paper Co., Brunswick, Ga.
Treasurer—J. W. Daniel, Union Bag-Camp Paper Corp., P. O. Box 570, Savannah, Ga.
Executive Committee—Officers and G. C. Kimble, Union Bag-Camp Paper Corp., Savannah, Ga.; J. Tracy, Rayonier, Inc., Jesup, Ga.; and V. F. Waters, Southern Pulp & Paper Manufacturer, Atlanta, Ga.

Virginia-Carolina Section (Chartered in 1957)

Chairman—Garland T. Edmonds, The Chesapeake Corp., West Point, Va.
Vice-Chairman—John W. Gladstone, Halifax Paper Co., Inc., Roanoke Rapids, N. C.
Secretary—Paul R. Kinsey, Riegel Paper Corp., Acme, N. C.
Treasurer—W. E. Bloxom, Continental Can Co., Hopewell, Va.
Executive Committee—Officers and G. S. Bailey, North Carolina Pulp Co., Plymouth, N. C.; J. L. Baker, Albemarle Paper Mfg. Co., Richmond, Va.; W. C. Chapman, Union Bag-Camp Paper Corp., Franklin, Va.; E. L. Dozier, Chesapeake Corp. of Va., West Point, Va.; W. A. Green, Jr., Manchester Board & Paper Co., Richmond, Va.; C. Vernon Henkel, Mead Corp., Lynchburg, Va.; R. B. Hobbs, Paper Section, National Bureau of Standards, Washington 25, D. C.; Ross Miller, Continental Can Co., Hopewell, Va.; G. W. Renninger, American Viscose Corp.,



R. A. Flick, Brunswick Pulp & Paper Co.; Southeastern

G. T. Edmonds, The Chesapeake Corp.; Virginia-Carolina

Fredericksburg, Va.; K. D. Running, Halifax Paper Co., Roanoke Rapids, N. C.; E. K. Scholz, West Virginia Pulp & Paper Co., Covington, Va.; R. H. Simmons, Bureau of Engraving, Washington, D. C.; C. E. Snook, Nopco Chemical Co., Charlottesville, Va.; and Roy Traver, Union Bag-Camp Paper Corp., Franklin, Va.

Review of 1960–61 Section Meetings

The following review is a record of the meetings held by the local sections of the Technical Association of the Pulp and Paper Industry between July, 1960, and June, 1961. A report of the meetings held in 1959–60 was published in the December, 1960, issue of *TAPPI*.

Chicago

Sept. 1, 1960 (Chicago Bar Assn.): "Developments in the Surface Design of Packages," by Lony Ruhmann, Container Corp. of America, Chicago, Ill.

Oct. 4, 1960 (Chicago Bar Assn.): Panel meeting on "New Ideas for Corrugated," Roy Caponi, Union Bag-Camp Paper Corp., Chicago, Ill., moderator. "The Glu-Wright Machine for Corrugated," by Albert W. Ascani, Liberty Engineering Co., Chicago, Ill.; "Avistrap—A New Cord Strapping for Unitizing," by Don R. Hager, American Viscose Co., Marcus Hook, Pa. "Dorr Rapi Die—A New System for Mounting Printing Dies," by Harvey Taylor, Dorr Sales & Engineering Co., Chicago, Ill.

Nov. 1, 1960 (Chicago Bar Assn.): Panel meeting on Production and End Use of Fine Paper," William Kenney, Weyerhaeuser Co., moderator. "Uncoated Printing Papers," by Gerry D'Addio, Mead Papers, Inc., Chicago, Ill.; "Machine Coated Printing Papers," by Lawrence Kussow, Kimberly-Clark Corp., Chicago, Ill.; and "Off-Machine Coated Printing Papers," by Clark Weymouth, S. D. Warren Co., Chicago, Ill.

Jan. 10, 1961 (Chicago Bar Assn.): Panel meeting on "Preparing for Career Opportunities in Pulp, Paper, and Packaging," Chicago High School vocational counselors present as guests. William Hall, moderator. Brief résumés by Alfred H. Nadelman and John Fanselow, Western Michigan University, Kalamazoo, Mich., and James W. Goff, School of Packaging, Michigan State University, Lansing, Mich.

Feb. 7, 1961 (Chicago Bar Assn.): Panel meeting on "Solid Bleached Sulfate Board as a Packaging Medium," A. L. Magnuson, Potlatch Forests, Inc., Chicago, Ill., moderator.

March 7, 1961 (Chicago Bar Assn.): Panel meeting on "The Development of Plastics as a Packaging Medium," Mike Hecht, Chicago Carton Co., Chicago, Ill., moderator. Panel Members: Ralph C. Krueger, E. I. du Pont de Nemours & Co., Chicago, Ill. (Plastic fibers and cellophane); Arthur E. Irvine, Union Carbide Co., Chicago, Ill. (Extension coatings); Warren C. Ashley, Pyroxylin Products, Inc., Chicago, Ill. (Solvent, water-based, and hot melt coatings); and R. Vernon Jones, Phillips Chemical Co., Chicago, Ill. (Molded containers).

April 4, 1961 (Chicago Bar Assn.): "Coating and Converting Equipment," by Ernest M. Cook and Thomas C. Potter, Dilts Division, Black-Clawson Co., Fulton, N. Y.

May 2, 1961 (Chicago Bar Assn.): Panel meeting on "Structural Design of Corrugated and Folding Cartons," William Kenney, Weyerhaeuser Co., moderator.

Delaware Valley

Sept. 14, 1960 (Anchorage Inn, Philadelphia, Pa.): "Quality of Sulfite Pulp for Papermaking," by Lennart G. Stockman, Central Laboratory, Stockholm, Sweden. Visit to mill of Hamilton Paper Co., Miquon, Pa.

Oct. 27, 1960 (Engineers Club, Philadelphia, Pa.): "Package Design and the Corporate Image," by William F. Meyer, Jr., Container Corp. of America, Manayunk, Pa.

Dec. 9, 1960 (Engineers Club): Panel meeting on "Stock Cleaning." Panelists: C. D. Coffman, Chesapeake Paperboard Co.; R. J. Harrison, Bird Machine Co.; John Pedrick, Scott Paper Co.; L. C. Van Guelpen, Black-Clawson Co.; John Verwayen, Mead Corp.; J. W. Wilson, Riegel Paper Corp.; and M. D. Woodruff, Bauer Bros. Co.

Jan. 26, 1961 (Engineers Club): "Smooth Paper Finish," by Don Ripley, Beloit Iron Works, Beloit, Wis.

March 17, 1961 (Benjamin Franklin Hotel, Philadelphia, Pa.): Philadelphia Conference of the Graphic Arts.

April 27, 1961 (Engineers Club): "A Simplified View of Sheet Formation," by S. T. Han, The Institute of Paper Chemistry, Appleton, Wis.

May 25, 1961 (Manufacturers Golf and Country Club, Oreland, Pa.): Edward J. Albert Award Night. "Evaluation of Laboratory and Mill Refining Equipment," by Dean R. Artz, P. H. Glatfelter Co., Spring Grove, Pa.; "Comparison of the Valley Beater with the Bauer-Mead Refiner," by Bruce G. St. Leger, Container Corp. of America, Manayunk, Pa.; "A Method for Evaluating Paper Plasticizers," by James Haggerty, Riegel Paper Corp., Milford, N. J.; "Some Requirements of a Water Repellent Agent," by Peter N. Yiannos, Scott Paper Co., Chester, Pa.

Empire State

Empire State (Whiteface Inn, Lake Placid, N. Y.): "New Developments in Wet End Operation,"; "The Inverformer," by William Goodwill, Beloit Iron Works; "The Rotoformer," by Vincent Long, Blandy Paper Co.; "Plastic Wires," by C. S. Lee, The Formex Co.; "Wire Doctors," by J. S. Cooper, Lodding Engineering Co.

June 10, 1961 (Whiteface Inn): "Modern Finishing Practices and Developments," "Supercalendering," by D. D. Anderson, International Paper Co.; "Electronic Sorting," by C. J. Rinfret, Rolland Paper Co.; "Abitibi Sorter," by M. P. McMartin, National Research Council; "Trimming," by Farhang Javid, Smith & Winchester Co.

Central District—Empire State

Sept. 9, 1960 (University Club, Syracuse, N. Y.): "Sulfite Pulp," by Lennart G. Stockman, Central Laboratory, Stockholm, Sweden.

Oct. 13, 1960 (University Club): "Some Practical Problems Associated with Cellulose-Water Relationships," by Wilfred Gallay, E. B. Eddy Co., Hull, Que. Visit to mill of St. Regis Paper Co., Deferiet, N. Y. (Joint meeting with Northern District at Woodruff Hotel, Watertown, N. Y.)

Nov. 4, 1960 (University Club): "Plastic Fourdrinier Wires," by C. A. Lee, The Formex Co.

Dec. 2, 1960 (University Club): "Rubber Roll Nip Impressions," by Malcolm McLeod, Stowe-Woodward Co., Newton Upper Falls, Mass.

Jan. 6, 1961 (University Club): "New Developments and Recent Trends in Coating," by George Booth, Black-Clawson Co., Fulton, N. Y.

Feb. 3, 1961 (University Club): "Water and Wood," by Neil J. Stout, Executive Director of the Joint Legislative Committee on Natural Resources of New York State.

March 3, 1961 (University Club): "New Developments in Corrugated Boxes," by Patrick Palmaccio, Mead Corp.

April 7, 1961 (University Club): New York State College of Forestry Senior Night. Address by Horace A. Spencer, Knowlton Bros., Watertown, N. Y.

May 5, 1961 (University Club): Annual Meeting.

Eastern District—Empire State

Oct. 29, 1960 (Queensbury Hotel, Glens Falls, N. Y.): Visit to Rensselaer Polytechnic Institute to see the nearly completed lineal accelerator at the dinner meeting at the Troy Country Club. John Lewis of R. P. I. discussed the accelerator and new teaching methods using closed circuit TV, etc.

Nov. 17, 1960 (Queensbury Hotel): "Nonwoven Fabrics," by Howard W. Shearer, American Viscose Corp., Marcus Hook, Pa.

Dec. 15, 1960 (Queensbury Hotel): "Kamyr Continuous Cooking," by Norman R. Baldwin, Kamyr, Inc., Hudson Falls, N. Y.

Jan. 19, 1961 (Queensbury Hotel): Annual Executives Night. "Additives in Paper as Related to the 1958 Amendment to the Food and Drug Act," by Ralph Russell, Syracuse University Research Corp., Syracuse, N. Y.

Feb. 16, 1961 (Queensbury Hotel): Panel meeting on "Preventive Maintenance," James Rogers II, Sandy Hill Iron & Brass Works, Hudson Falls, N. Y., moderator. Panelists included Roy Sharp, West Virginia Pulp & Paper Co., Mechanicville, N. Y.; Joseph Harris, International Paper Co., Palmer, N. Y.; Paul Martineau, Sandy Hill Iron & Brass Works; Carl Kroetz, Finch, Pruyn & Co., Glens Falls, N. Y.; and L. F. Wendorf, Marinetti Paper Co., Fort Edward, N. Y.

March 16, 1961 (Queensbury Hotel): Junior Award Contest Papers and High School Essay Contest (117 papers offered to judges.) Guy B. Stiles, Sandy Hill Iron & Brass Works, won junior award for "Ductile Iron as Related to the Paper Industry."

April 20, 1961 (Queensbury Hotel): Annual Symposium "Printing and Paper." William C. Walker, West Virginia Pulp & Paper Co., Williamsburg, Pa., moderator. "Gravure Printing," by F. W. Goetz, Publication Corp., New York, N. Y.; "Letterpress Printing," by E. C. Brown, McCall Corp., Dayton, Ohio; and "Offset Printing," by William Palinski, Western Printing & Lithographing Co., Poughkeepsie, N. Y.; "Frontiers in Printing Research," by Albert S. Zettlemoyer, National Printing Ink Research Institute, Lehigh University, Bethlehem, Pa.

May 20, 1961. Annual meeting at Top O' The World, Lake George, N. Y.

Metropolitan District—Empire State

Sept. 13, 1960 (465 Restaurant, New York, N. Y.): "The Selection and Training of Technical Personnel," by William H. Aiken, Personal Products Co., Milltown, N. J.

Oct. 11, 1960 (465 Restaurant): "The Role of Chemicals in Bleaching Commercial Wood Pulps," by John Schuber, Solvey Division, Allied Chemical Corp., Syracuse, N. Y.

Nov. 9, 1960 (465 Restaurant): "Investing in the Paper Industry," by Louis T. Stevenson, Tucker, Anthony and R. L. Day Co., New York, N. Y.

Dec. 13, 1960 (465 Restaurant): "Dyeing of Paper," by Joseph Gessner, E. I. du Pont de Nemours & Co., Inc., Carney's Point, N. J.

Jan. 10, 1961 (465 Restaurant): "Forecast for 1961," by W. R. Adams, St. Regis Paper Co., New York, N. Y.

March 14, 1961 (465 Restaurant): "The Pulp & Paper Industry in Europe," by Albert W. Wilson, Pulp & Paper, New York, N. Y.

April 11, 1961 (465 Restaurant): "The Food Additives Law," by Keith Max, Continental Can Co., New York, N. Y.

Northern District—Empire State

Oct. 13, 1960 (Hotel Woodruff, Watertown, N. Y.): "Some Practical Problems Associated with Cellulose-Water Relationships," by W. Gallay, E. B. Eddy Co., Hull, Que. (Joint meeting with Central District.)

Nov. 10, 1960 (Hotel Woodruff): "The Measurement of Fiber Flexibility," by A. A. Robertson, Pulp and Paper Research Institute of Canada, Montreal, Que.

Dec. 8, 1960 (Hotel Woodruff): Students Night. Address by P. E. Nethercut, TAPPI, New York, N. Y.

Jan. 12, 1961 (Hotel Woodruff): "Pulp & Paper Research and Development in Western Europe and the U.S.S.R.," by B. G. Ranby, Empire State Paper Research Institute, New York State College of Forestry, Syracuse, N. Y.

Feb. 9, 1961 (Hotel Woodruff): "Problems in Research and Development for Small Specialty Mills," by F. C. Keeney, Knowlton Bros. Co., Watertown, N. Y.

March 9, 1961 (Levis House, Carthage, N. Y.): "The Relative Effect of Refining, Wet-pressing, and Fiber Species on Tensile Strength and Opacity." Junior award paper by Maynard Nieboer, St. Regis Paper Co., Carthage, N. Y. Visit to mill of Crown Zellerbach Corp., Carthage, N. Y.

April 13, 1961 (Hotel Woodruff): "The Planning of a Technical Center," by K. A. Arnold, St. Regis Paper Co., New York, N. Y. Joint meeting with Beaver Falls Chapter, American Institute of Chemists.

May 11, 1961 (Hotel Woodruff): Annual Meeting. Talk by Atomic Energy of Canada, Ltd., Ottawa, Canada.

Western District—Empire State

April 5, 1961 (Village Tavern, Alcott, N. Y.): Showing of film "Production of Felts." Panel meeting. Panelists: Fred P. Heil, chief designer, Thomas Faltz, chief chemists, and Henry Stuart, director of textile research and development of Lockport Felt Co. Visit to plant of Lockport Felt Co., Newfane, N. Y.

April 29, 1961: Annual Meeting. Hardings, Youngstown, N. Y.

Golden Gate

Sept. 26, 1960 (Claremont Hotel, Berkeley, Calif.): "Kraft Pulp," by Lennart Stockman, Royal Institute of Technology, Stockholm, Sweden.

Nov. 29, 1960 (Sabella's Restaurant, San Francisco, Calif.): "Recent European Packaging Developments," by E. A. Mitchell, Crown Zellerbach Corp., San Francisco, Calif.

Jan. 24, 1961 (El Rio Motel, Antioch, Calif.): "Long Range Water Supply Problems of Central California Pulp and Paper Industry," by W. J. O'Connell, Consultant. Visit to mill of San Joaquin Division, Fibreboard Paper Products Co., Antioch, Calif.

March 21, 1961 (Crown Zellerbach Bldg., San Francisco, Calif.): "Coloring of Paper and Board," by Morris J. Landberge, General Aniline & Film Corp., Rensselaer, N. Y.

May 9, 1961 (Claremont Hotel): "Practical Significance of Laboratory Tests for Paper and Board," by James d'A. Clark, professor of chemical engineering, Oregon State College, Corvallis, Ore.

Gulf Coast

Oct. 7–8, 1960 (San Carlos Hotel, Pensacola, Fla.): "Six Months Outside Storage of Pine and Hardwood Chips," by A. W. Brinkley, International Paper Co., Panama City, Fla.; "A Statistical Answer to the Problem of Acceptance Sampling of Roll Stock," by J. H. Moyer, Champion Paper & Fibre Co., Pasadena, Tex.; "Printability from Several Points of View," by W. Keith Gainer, International Paper Co., New York, N. Y. Visit to plant of Newport Industries Co., Pensacola, Fla.

Dec. 2–3, 1960 (Lamar Hotel, Meridian, Miss.): "Continuous Control of Bleaching in a Broke System," by A. D. Harbin, Diamond Alkali Co., Painesville, Ohio; "Some Timber Management Effects on the Papermaker," by Frank A. Albert, manager of lands and forests, St. Regis Paper Co., Mobile, Ala.; "Contribution of Acrylic Polymers to Paper Products," by Paul J. McLaughlin, Rohm & Haas Co., Philadelphia, Pa. Visit to mill of Marathon Div., American Can Co., Naheola, Ala.

Feb. 3–4, 1961 (Tutwiler Hotel, Birmingham, Ala.): "Laminating, Coating and Printing of Aluminum Foil," by James T. Trousdale, Anaconda Aluminum Co.; "Surface Sizings and Coatings for Paper and Paperboard," by C. R. Vander Meulen, Penick & Ford Ltd., Cedar Rapids, Iowa. Visit to mill of Coosa River Paper Co., Coosa Pines, Ala.

April 7–8, 1961 (The Pines Hotel, Pine Bluff, Ark.): "Papers Magic Carpet" (film) comments by J. B. Basken and Joseph Churchville, Huyck Felt Co., Aliceville, Ala.; "Smooth Paper Finish," by J. S. Shaver, Beloit Iron Works, Beloit, Wis. Visit to mill of International Paper Co., Pine Bluff, Ark.

May 26–27, 1961 (Royal Orleans Hotel, New Orleans, La.): "Know Your Drier Felts," by D. F. Elmore, Asten-Hill Mfg. Co., Philadelphia, Pa.; "Cheaper Chlorine Dioxide Bleaching," by W. Howard Rapson, consultant for Hooker Chemical Co., University of Toronto, Toronto, Ont. Visit to mill of Crown Zellerbach Corp., Bogalusa, La.

Sezione Italiana

Oct. 29, 1960 (Torino, Italy): "Report of the Testing Methods Committee on Relative Humidity of Paper for Paper Testing," by E. Grandis, Cartiere Burgo, Torino, Italy.

Dec. 14, 1960 (Torino, Italy): "Report of the Groundwood Committee on 1960 Activities," by D. Borruso, Stazione Sperimentale per la Carta e Cellulosa.

March 15, 1961 (Torino, Italy): Annual Meeting. "The Human Factor in the Paper Industry," by Piero Bersano, Cartiere Burgo, Torino, Italy.

Kalamazoo Valley

Sept. 28, 1960 (Pantlind Hotel, Grand Rapids, Mich.): "The Present Status of Atomic Power Development," by Walker Cisler, Detroit Edison Co., Detroit, Mich. (Joint banquet with 11th Testing Conference.)

Nov. 16, 1960 (Hotel Harris, Kalamazoo, Mich.): "Recent Theoretical Work in the Area of Sheet Formation," by Joseph Parker, Beloit Iron Works, Beloit, Wis. (Joint meeting with Michigan Division of Paper Industry Management Association). "Upgrading Machine Room and Stock Preparation Equipment for Increased Productivity," by Paul Petzold, Oxford Paper Co., Rumford, Maine.

Dec. 8, 1960 (Suman's Restaurant, Galesburg, Mich.): Panel meeting on "Papermaking Properties of Pulp." W. A. Lunsford, Consolidated Paper Co., Monroe, Mich., moderator. Panelists: "Hardwood Kraft Pulp," by W. H. Marra, S. D. Warren Co., Muskegon, Mich.; "Blends of Hardwood and Softwood Kraft Pulp," by B. C. McMahon, Packaging Corp. of America, American Box Board Co., Filer City, Mich.; and "Semichemical Pulp," by John C. Tongren, Hammermill Paper Co., Watervliet, Mich.

Jan. 19, 1961 (Hotel Harris): 26th Annual Paper Makers Get-Together-Joint PIMA TAPPI banquet. Frank Roberts, S. D. Warren Co., Muskegon, Mich., toastmaster. "Evaluating Personal Potentials in Order to Live a Full Life," by Glen Massman.

March 16, 1961 (Suman's Restaurant): "Color Harmony and Color Control," by Arlene Nelson, Container Corp. of America, Chicago, Ill.; "Quality Control on Large Multicolor Offset Presses," by Robert E. Wood, Western Printing and Lithographing Co., Racine, Wis.; "Use of Color in Packaging Design," by Morton Goldscholl, Design Associates, Inc. (Joint meeting with PIMA Michigan Division and Michigan Club of Printing House Craftsmen).

April 6, 1961 (Suman's Restaurant): "New Uses of Paperboard," by L. K. Burnett, Packaging Corp. of America, Rittman, Ohio. Visit to mill of Michigan Carton Co., Battle Creek, Mich.

May 25, 1961 (Gull Harbor Inn, Kalamazoo, Mich.): Annual Meeting. This meeting is held to honor the senior students of the pulp and paper course at Western Michigan University. Student Papers: "Effect of Latices on Casein-Clay Coatings," by James E. Cline; "The Effect of Acid Pre-treatment on Hydrogen Peroxide and Zinc Hydrosulfide Bleached Deinked Stock," by Philip E. Sturman; "The Influence of Cationic Starch on Hygroexpansivity of Paper," by Anthony R. Wagner.

June 20, 1961 (Gull Lake Country Club). Joint Fun-Day with Michigan Division of PIMA.

Lake Erie

Oct. 6, 1960 (Cleveland Engineering Society, 3100 Chester Ave., Cleveland, Ohio): Panel Meeting. "How do You the Supplier Maintain Uniformity in Your Products?" Panelists: Otto Kroeschell, Michigan Carton Co., Battle Creek, Mich. (Boards); Don Zessak, Printing Ink Division, Interchemical Corp., Cleveland, Ohio, (Inks); and Lawrence Ricket, Edes Nietal Co., Photoengraving Division, Revere Copper & Brass Co., Los Angeles, Calif.

Nov. 3, 1960 (Cleveland Engineering Society): "New Instruments for Process Control," by Russell Lewis, Packaging Corp. of America, Rittman, Ohio.

Dec. 1, 1960 (Stouffer's Playhouse Square, 14th and Euclid, Cleveland, Ohio): Visit to Frozen Cooked Foods Kitchen of Stouffer Co., 3800 Woodland Ave., Cleveland, Ohio. Joseph Dwyer, purchasing manager of Stouffers described operations.

Feb. 2, 1961: Visit to plant of Harris-Seybold Co., 4510 East 71 St., Cleveland, Ohio.

March 2, 1961 (Cleveland Engineering Society): "Paper and Paper Technology—It's Future as a Profession," by C. E. Brandon, Miami University, Oxford, Ohio.

April 6, 1961 (Midway Motel, 6455 Pearl Road, Parma Heights, Ohio): "Letterpress Printing," by J. F. Manning, Dairypak-Butler, Inc., Clinton, Iowa, and "Flexographic Printing," by R. Taplesbay, Dobeckman Co., Division of Dow Chemical Co., Cleveland, Ohio.

June 10, 1961 (Greenbrier Restaurant, Parma Heights, Ohio): Annual Meeting.

Lake States

Sept. 14, 1960 (Wausau, Wis.): "Programming Results for Microbial Control," by R. E. Eddy, Nalco Chemical Co., Chicago, Ill. Visit to Wausau Carton Plant of American Can Co., Wausau, Wis.

Oct. 12, 1960 (Beloit, Wis.): "Problems of Drainage and Increased Wire Life on High Speed Fourdrinier Paper Machines," by Raymond Martens and Robert Clark, Beloit Iron Works; "The Flo-Vac Unit," by C. J. Clark, Clark & Vicario, North Tarrytown, N. Y. Visit to plant of Beloit Iron Works, Beloit, Wis.

Nov. 16, 1960 (Green Bay, Wis.): "Design of Experiments," by Harry H. Hull, R. R. Donnelley & Sons, Chicago, Ill.; "Statistical Quality Control in Engineering Research and Development," by Paul S. Olmstead, Bell Telephone Laboratories, Whippany, N. J. Visit to mill of Nicolet Paper Co., West De Pere, Wis. Joint meeting with Winnebago Section of the American Society for Quality Control.

Jan. 11, 1961 (Elks Club, Appleton, Wis.): "Beater Adhesives," by John Swanson, The Institute of Paper Chemistry, Appleton, Wis. Dinner to honor past chairmen of the Lake States Section.

March 14, 1961 (Kaukauna, Wis.): "Importance of Hardwoods to the Pulp and Paper Industry," by Warren A. Chilson, Forest Products Laboratory, Madison, Wis.

April 11, 1961 (Menasha, Wis.): "A Career in the Paper Industry," by Robert B. Otto, Hercules Powder Co., Milwaukee, Wis. (C. J. West Award winning paper); "Strength Evaluation of Pulps," by Edward J. Jones, The Institute of Paper Chemistry, Appleton, Wis. Visit to the mill of the Neenah Paper, Division of Kimberly-Clark Corp., Neenah, Wis.

May 11, 1961 (Green Bay, Wis.): "Instrumentation and Its Future," by Lincoln B. Thiesmeyer, Pulp and Paper Research Institute of Canada, Montreal, Que. Meeting held in conjunction with the national conference on Pulp and Paper Instrumentation.

Maine-New Hampshire

Nov. 4–5, 1960 (Lafayette Hotel, Portland, Me.): "Surface Treatment of Paper and Board with Starch Pigments," by J. E. Killinger and John P. Bainbridge, Penick & Ford Ltd., Inc., Cedar Rapids, Iowa; "Some Recent Research on Resin 238 Accrustrength," by Walter F. Reynolds, American Cyanamid Co., Stamford, Conn.; "CMC as a Paper Machine Additive," by E. J. Barber, Virginia Cellulose Division, Hercules Powder Co., Wilmington, Del.

Jan 12, 1961 (Bangor House, Bangor, Me.): "Discussion of Literature on Instruments for Formation Evaluation," by Joseph W. King and Eben M. Whitcomb, Standard Packaging Corp., So. Brewer, Me.; "Some Aspects of Sheet Formation," by R. M. Wishart, Oxford Paper Co., Rumford, Me. Visit to mill of Eastern Fine Paper and Pulp Division, Standard Packaging Corp., So. Brewer, Me.

June 9–10, 1961 (Wentworth by the Sea, Portsmouth, N. H.): "Chelating Agents in Papermaking," by Andrew Gard, Industrial Chemical Technical Co. Chelate Chemicals Corp., Boston, Mass.; "Pulp Bleaching with Peroxide," by Robert Kindron and Frederick Rosebush, Becco Division, Food Machinery & Chemical Corp., Buffalo, N. Y.; "Economic Justification of Instrumentation," James Overall, Fischer & Porter Co., Atlanta, Ga.; "Continuous Freeness Record Controller," by George L. Harman, Bailey Meter Co., Milwaukee, Wis.; "Applications and Limitations of Beta Gage," by Robert Nero, Tracerlab, Inc., Boston, Mass.; "Chemically Beaten Pulp," by Herbert Freedman, Penobscot Chemical Fibre Co., Great Works, Me., and Arthur M. Goldstein, Stein Hall Co., New York, N. Y.; "Recent Advances in Pulp Bleaching with Chlorine Dioxide," by John Schuber, Solvey Process Division, Allied Chemical Corp., Syracuse, N. Y.; "Hydrosulfite Bleaching of Groundwood-Mill Applications," by Robert Barton, Virginia Chemicals & Smelting Co., Norfolk, Va.; Helen U. Kiely Award for prize paper competition to Norman Veillette, Lowell Technological Institute, Lowell, Mass., and New England TAPPI Student Award to Ernest Tessier, Lowell Technological Institute.

New England

Oct. 7–8, 1960 (Schine Inn, Chicopee, Mass.): "Paper Curl Problems," by Wilfred Gallay, E. B. Eddy Co., Hull, Que., and "Economics of Asphalt Emulsions," by R. C. Barbour, Consultant, New Rochelle, N. Y. Joint meeting with Connecticut Valley Division of PIMA.

June 9–10, 1961 (Wentworth by the Sea, Portsmouth, N. H.): See Maine-New Hampshire report.

Bay District—New England

Sept. 12, 1960 (Armando Beacon Terrace, Route 9, Framingham, Mass.): "The Aquapel Story," by Cyrus A. Weisgerber and Clarence B. Hanford, Hercules Powder Co., Wilmington, Del.

Nov. 14, 1960 (Armando Beacon Terrace): "Can New England Paper Mills Stay in Business?" by Stuart U. Rich, Harvard Business School, Cambridge, Mass. Panelists: George Wallace III, Fitchburg Paper Co., Fitchburg, Mass.; Amor Hollingsworth, Tileston & Hollingsworth Co., Hyde Park, Mass.; Norman I. Bearse, Oxford Paper Co., Lawrence, Mass.; and Bartow Kelly, Crocker, Burbank Papers, Inc., Fitchburg, Mass.

Jan 9, 1961 (Armando Beacon Terrace): "A New Retention Aid for Filler, Pigment, and Fiber," by Norman Woodberry, American Cyanamid Co., Stamford, Conn.

March 14, 1961 (Armando Beacon Terrace): Panel on "Office Copy Methods and Special Papers for Office Copy," Panelists: D. D. Uong, Fitchburg Paper Co., Fitchburg, Mass., and L. A. Zehner, Jr., Arthur D. Little, Inc., Cambridge, Mass.

Berkshire District—New England

Nov. 1, 1960 (Pittsfield Country Club, Pittsfield, Mass.): "Glass, a Component of Paper," by Alfred Marzacchi, and Leslie L. Warner, Owens-Corning Fiberglas Corp., Newark, Ohio, and "Fiber Selection and Engineering Design for Papers," by William Selke, Peter J. Schweitzer Division, Kimberly Clark Corp., Lee, Mass.

Jan. 10, 1961 (Pittsfield Country Club): "The Nature of Pulps," by A. E. H. Fair, Consultant, Boston, Mass., and "Modified Cellulose Products," by R. A. Leonard, Hercules Powder Co., Wilmington, Del.

March 7, 1961 (Hotel Wendell Sherwood, Pittsfield, Mass.): "What's New in Drying," by Richard C. Gillette and J. A. Villalobos, J. O. Ross Engineering Corp., New York, N. Y., and "Mechanism of Drying in Drier Felts," by Hand Dirzeweit, Huyck Felt Co., Rensselaer, N. Y.

May 2, 1961 (Pittsfield Country Club): "Grade Costs—Composition and Utility," by Paul Wilks, Strathmore Paper Co., W. Springfield, Mass., and "Costs of Replacement and Installing New Equipment," by E. K. Bancroft, Hurlbut Paper Co., So. Lee, Mass., and F. S. Klein, Byron Weston Paper Co., Dalton, Mass.

Pioneer Valley—New England

Dec. 5, 1960 (Storrowtown Tavern, W. Springfield, Mass.): Panel meeting on "Composition, Application and Expected Results of the Use of Optical Brightness," Panelists: George Coble, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., M. J. Landberge, General Aniline & Film Corp., Rensselaer, N. Y., Thomas Harkavy, Geigy Chemical Co., Yonkers, N. Y., and Fred Sundstrom, American Cyanamid Co., Bound Brook, N. J.

April 10, 1961 (Storrowtown Tavern): "Perception in Observation," by Barton K. Feroe, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Ohio

Sept. 13, 1960 (Manchester Hotel, Middletown, Ohio): "The Quality of Sulfite Paper Pulp," by L. G. Stockman, Royal Institute of Technology, Stockholm, Sweden.

Oct. 13, 1960 (Manchester Hotel): Panel meeting on "Continuous Pulping and Stock Preparation," Panelist: Edward J. Jones, Institute of Paper Chemistry, Appleton, Wis.

Nov. 15, 1960 (Manchester Hotel): "Significance of Election Results as it Pertains to the Paper Industry," by Paul F. Schenk, Congressman, Third Ohio District. Joint meeting with Miami Valley, PIMA.

Dec. 15, 1960 (Manchester Hotel): "Plastic Fourdrinier Wires," by Charles A. Lee, Formex Div., The Huyck Corp., Knoxville, Tenn.

Jan. 10, 1961 (Manchester Hotel): "Some Recent Advances in Interfiber Bonding with Wet-End Additives," by Merchant L. Cushing, A. E. Staley Mfg. Co., Decatur, Ill.

Feb. 9, 1961 (Manchester Hotel): "Trailer Blade Coating," by Harold M. Annis, Oxford Paper Co., New York, N. Y.

March 14, 1961 (Miami University, Oxford, Ohio): "Appearance Properties of Paper," by Richard S. Hunter, Hunter Associates Laboratory, McLean, Va.

April 13, 1961 (Colony Club, Dayton, Ohio): "NCR Capsular Development," by R. W. Saudberg, National Cash Register Co., Dayton, Ohio. Tour of plant of National Cash Register Co.

May 11, 1961 (Hartwell Recreation Hall, Cincinnati, Ohio): Annual Meeting.

Indiana District—Ohio

Sept. 20, 1960 (Marott Hotel, Indianapolis, Ind.): "The Value of Good Communications to the Technical Man," by Robert J. Irvin, Inland Container Corp., Indianapolis, Ind.

Oct. 18, 1960 (Columbus, Ind.): "Application of High Polymers to Paper and Board," by Paul McLaughlin and Frederick Schucker, Rohm & Haas Co., Philadelphia, Pa. Visit to plant of Riegel Paper Corp., Edinburg, Ind.

Nov. 15, 1960 (Marott Hotel): "Smooth Paper Finishes," by Ralph Mahony, Beloit Iron Works, Beloit, Wis.

Dec. 20, 1960 (Marott Hotel): "Plastic Printing Plates in the Graphic Arts," by Hal Benham, Benham Press, Indianapolis, Ind., and Georg Bukovsky, E. I. du Pont de Nemours & Co., Wilmington, Del.

Jan. 17, 1961 (Butler University, Indianapolis, Ind.): "What's Important in Quality Control," by Charles R. Hicks, Purdue University, Lafayette, Ind. Joint meeting with American Society for Quality Control.

Feb. 14, 1961 (Marott Hotel): "Quality Control in Practice." Panelists: W. B. Lincoln, Jr., Inland Container Corp., J. E. Maphis, Container Corp. of America, Wabash, Ind., Keith Reichard, and Harris O. Ware, Beveridge Paper Co., Indianapolis, Ind.

March 21, 1961 (Marott Hotel): "Who We Are and What We Do," by Alfred H. Nadelman, consultant, Kalamazoo, Mich. (Indiana high school science teachers were guests.)

April 18, 1961 (Durbin Hotel, Rushville, Ind.): "Beater Room Equipment," by Neil S. Balfour, Beveridge Paper Co., Indianapolis, Ind. Visit to corrugating medium plant of Container Corp. of America, Wabash, Ind.

May 16, 1961 (Marott Hotel): "Effect of Recent Amendments of the FDA Regulations on the Paper and Paperboard Industry," by Robert M. Miller, Hercules Powder Co., Wilmington, Del.

June 15, 1961 (Anderson Country Club, Anderson, Ind.): Fourth Annual Golf Outing.

Pacific

Sept. 19–20, 1960 (Seattle, Wash.) and *Sept. 22–23, 1960* (Portland, Ore.): Fourteenth Annual Seminar. "Some Current Questions in Chemical Pulping," by Lennert Stockman, Royal Institute of Technology, Stockholm, Sweden.

Nov. 16, 1960 (Salem, Ore.): "Two Changes in Sulfite Mill Acid Plant Operations," by Donald R. Davis, Publishers' Paper Co., Oregon City, Ore.; "New Applications in Kraft Pulping," by J. B. Esselman, Georgia-Pacific Paper Co., Toledo, Ore.; "How Flash Drying Affected Lime Mud Reburning and Recausticizing Operations," by Felix M. Hammack, Western Kraft Comp., Albany, Ore.

Jan. 17, 1961 (Tacoma, Wash.): Process and Quality Control Techniques. "Fiber Loss Control," by D. B. Loyd, Mac Millan, Bloedel and Powell River, Ltd., Port Alberni, B. C.; "Measuring the Delamination of Paperboard," by R. R. Marriott, Crown Zellerbach Corp., Port Townsend, Wash.; "Automatic Blow Tank Sampler," by J. M. Elder, Weyerhaeuser Co., Everett, Wash.; "Black Cloth Dust Check on Coated Paper," by R. A. Watt, Crown Zellerbach Corp., West Linn, Ore.; "Pulp Chlorination Improvements at St. Helens," by A. A. Schlumberger, Hooker Chemical Co., Tacoma, Wash.; "The Skid Resistance Tester—An Instrument for Measuring Surface Resistance to Slip on Paper and Paperboard," by A. J. Beauchamp, Crown Zellerbach Corp., Camas, Wash.; "Curing of Handsheets by Far Infrared Radiation," by Bayard Carlson, American Marietta Co., Seattle, Wash.; and "The Function of Quality Control," by J. J. Whyte, St. Regis Paper Co., Tacoma, Wash.

March 21, 1961 (Longview, Wash.): Shibley Award Meeting. "Pitch Measurement and Control," by Donald J. Larkin, Crown Zellerbach Corp., Camas, Wash.; "Simplifying Experimental Research by Factorial Design," by John Melcher III, Puget Sound Pulp & Timber Co., Bellingham, Wash.; "The Application of the Polarizing Microscope to the Study of Wood and Fiber Structure," by Alec Jackson, Fiber Research, Seattle, Wash.

May 4–6, 1961 (Harrison Hot Springs, B. C.): "Fisheries Statistics in Evaluating Claims of Pollution," by R. Tollefson, consulting biologist, Toledo, Ore.; "The Influence of Wood Damage on Pulp Quality," by J. E. Stone, Pulp & Paper Research Institute of Canada, Montreal, Que.; "New Approaches to Pulp Evaluation," by John Swanson and E. D. Jones, The Institute of Paper Chemistry, Appleton, Wis.; "Kamyr Digester Start-up at San Joaquin Pulp and Board Mill," by Paul Olsen, Fiberboard Paper Products Corp., Antioch, Calif.; "Heat and Water Utilization in a Single Unit Kraft Mill," by E. T. Guest, B. C. Forest Products, Ltd., Crofton, B. C.; "Acorns and Nails in a Kraft Pulp Mill," by Kenneth Shold, Crown Zellerbach Corp., Port Townsend, Wash.; "Batch Digester Relief Control," by D. A. Kurg, Elk Falls Co., Ltd., Campbell River, B. C.; "Control of Maintenance Costs by Classified Work Orders," by Don Felthaus, Weyerhaeuser Co., Longview, Wash.; "New Trends in Gear Drives," by C. C. Harsliberger, Western Gear Corp., Seattle, Wash.; "Cast Iron Hydropulper Tub Rebuild Using Fiberglas and Epony Resin," by W. H. Taylor, Westminster Paper Co., Ltd., New Westminster, B. C.; "Sealed Insulation Systems for Electric Motors," by John Hohnquest and V. Rayner, Weyerhaeuser Co., Longview, Wash.; "Fundamentals of Foam and Defoaming," by R. W. Ramsdell and Leroy Dieffenbach, Hercules Powder Co., Portland, Ore.; "Steam Stripping of Volatile and Odorous Substances from Kraft Pulp Mill Aqueous Streams," by Matteson, Maah, Johanson, and McCarthy, University of Washington, Seattle, Wash.; "Recent Trends in Chlorine Dioxide Bleaching of Western Kraft," by D. D. Huirichs, Crown Zellerbach Corp., Camas, Wash.; "Feeding Molten Sulfur Directly from Tank Cars to Vaporizers," by A. Steiglider, Columbia Cellulose Co., Ltd., Prince Ruppert, B. C.: "The Identification of Spots in Paper by Chromatography," by F. P. Hughes, Inland Paper Co., New Westminster, B. C.; "Semiautomatic Stock Systems," by R. A. Little, Crown Zellerbach Corp., Camas, Wash.; "Converting Plant Studies with the High Speed Camera," by R. G. Tacheron, Crown Zellerbach Corp., Camas, Wash.; "Breaker Stock Application on High Speed Newsprint," by H. V. Rankin, Mac Millan, Bloedel & Powell River, Ltd., Port Alberni, B. C.; "New Fine Paper Machine at Howard Smith Mill," (Dominion Engineering Co.) Joint meeting of Pacific Section, TAPPI, Pacific Coast Branch, C.P.P.A. Technical Section, and Pacific Coast Division, PIMA.

St. Louis

Sept. 15, 1960 (Le Chateau Restaurant, 10405 Clayton Rd., St. Louis, Mo.): "The Use of Cellulosic Derivatives and Chlorinated Rubber as Film Formers," by Robert R. Stover, Hercules Powder Co., St. Louis, Mo.

Nov. 17, 1960 (Le Chateau Restaurant): "Recent Advances in the Packaging Field," by Carl P. Olstad, Crown Zellerbach Corp., Western Waxide Division, St. Louis, Mo.

Jan. 19, 1961 (Le Chateau Restaurant): "New Plastics New Uses," by Herman F. Mark, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

April 20, 1961 (Anheuser-Busch, Inc., Cafeteria, St. Louis, Mo.): "Paper and Ink Relationships," by John C. Braznell, Champion Paper & Fibre Co., St. Louis, Mo.

Southeastern

Sept. 16–17, 1960 (Jacksonville, Fla.): "Outside Summer Storage of Hardwood Chips in the South," by T. P. Crane, Jr., St. Regis Paper Co., Jacksonville, Fla., and D. L. Fassnacht, U. S. Forest Service, "Screen Cleaning of Paper Mill Headbox Stock," by W. Buedingen, Owens Illinois Glass Co., Valdosta, Ga.; "Quality and Yield of Kraft Pulp," by L. G. Stockman, Central Laboratory of the Swedish Cellulose Industry, Stockholm, Sweden. Visit to mill of Container Corp. of America, Fernandina Beach, Fla.

Nov. 18–19, 1960 (Atlanta, Ga.): "Fatigue Resistance of Extensible and Conventional Kraft Papers," by Julius H.

Mappus, West Virginia Pulp & Paper Co., Charleston, S. C.; "Self Heating of Paper," by M. B. Cunningham, Sonoco Products Co., Hartsville, S. C.; "How Paperboard Properties Affect Corrugated Container Performance," by K. Q. Kellicut, Forest Products Laboratory, Madison, Wis. Visit to plants of Atlanta Wire Works and Atlantic Steel Co.

Jan. 20–21, 1961 (Charleston, S. C.): "Stock Aeration Effects," by J. W. Tester, Container Corp. of America, Fernandina Beach, Fla.; "Mill Measurement of Liquid Soda Losses," by R. J. Kelly, Union Bag-Camp Paper Corp., Savannah, Ga.; "Tree Farming Is Our Future," by L. A. Whittle, Brunswick Pulp & Paper Co., Brunswick, Ga.; "Automatic Sampling and Analytical Screening of Purchased Chips," by James C. McKee, Union Bag-Camp Paper Corp., Savannah, Ga.; "An Impact Meter for Recording Sewer Flow," by W. J. Ervin, Brunswick Pulp & Paper Co., Brunswick, Ga.; Sodate Method for Analyzing Neutral Sulfite Semichemical Liquors," by John Morris, Herty Foundation Laboratory, Savannah, Ga.; "The G.C.M.I. Friction Tester," by James Sackellares, Continental Can Co., Port Wentworth, Ga.; "Sealability Testing," by C. L. Rucker, Container Corp. of America, Fernandina Beach, Fla.; "Design of a Humidity Control Test Room," by Lawrence L. Clapp, St. Regis Paper Co., Pensacola, Fla.

March 24–25, 1961 (Augusta, Ga.): "Problems of High Speed Paper Machines," by Arthur E. Dentremont, Great Northern Paper Co., Millinocket, Me.; "What's New at Augusta," by C. W. Ray, Continental Can Co., Augusta, Ga.; "Augusta Paper Mill Start-up," by B. C. Moore, Continental Can Co., Augusta, Ga.; "Research Trends in the Paper Industry," by A. H. Nissan, Rensselaer Polytechnic Institute, Troy, N. Y. Visit to mill of Continental Can Co., Augusta, Ga.

May 19–20, 1961 (General Oglethorpe Hotel, Wilmington Island, Ga.): "Foam and Pitch Control," by John W. Swanson, The Institute of Paper Chemistry, Appleton, Wis. Panel meeting on "Hot Stock Screening." Panelists: Robert J. Kelley, Union Bag-Camp Paper Corp., Savannah, Ga., Albert L. Conver, Rome Kraft Co., Rome, Ga., M. J. Dunford, Continental Can Co., Augusta, Ga., Robert W. Stoertz, West Virginia Pulp and Paper Co., Charleston, S. C., and Ralph C. Nall, Union Bag-Camp Paper Corp., Annual Meeting.

Virginia-Carolina

Sept. 30–Oct. 1, 1960 (Roanoke Rapids, N. C.): "Aluminum Foil Laminations," by Yale M. Brandt, Reynolds Metals Co., Richmond, Va.; "Kraft Paper Moisture Studies," J. W. Gladstone, Halifax Paper Co., Roanoke Rapids, N. C.; "Halifax Paper Co. Operations," by K. F. Adams. Visit to mill of Halifax Paper Co.

Nov. 18, 1960 (John Marshall Hotel, Richmond, Va.): "Short Term B.O.D. Studies," by Robert Anderson, Albermarle Paper Mfg. Co., Richmond, Va.; "Automatic Wire Tensioning," by Edward Carter, The Chesapeake Corp., West Point, Va.; "Practical Application of Statistics to Pulp and Paper Mill Operations," by Robert Hitchings, North Carolina State College, Raleigh, N. C.; and "Tall Oil Operations, Products, and End Uses," by Morris Kelly, Hercules Powder Co., Wilmington, Del.; "Research in the Paper Industry," by Alfred H. Nissan, Rensselaer Polytechnic Institute, Troy, N. Y.

March 10, 1961 (John Marshall Hotel): "Improved Defibering and Capacity Increases in Stock Preparation Pulpers" (Black-Clawson Co.); "Maintenance Control Center," by C. B. Vann, Riegel Paper Corp., Acme, N. C.; "In-Plant Pollution Control," by H. D. Jurgenson, North Carolina Pulp Co., Plymouth, N. C.; "Theory and Paper Machine Application of High Velocity Air Drying," by Ray Vonderau, Beloit Iron Works, Beloit, Wis.; "The State Water Control Board and the Paper Industry," by A. H. Paessler, State Water Control Board, Richmond, Va.

April 25, 1961 (Virginian Hotel, Lynchburg, Va.): "Employee Training," by Fairmont F. White, Newport News Shipbuilding and Dry Dock Co., Newport News, Va. Annual Meeting. Visit to mill of Mead Corp., Lynchburg, Va.

Chicago

"The Development of Plastics as a Packing Medium" was the topic presented by a nationally known, distinguished panel of experts to a record turnout of 165 members and guests of Chicago Section TAPPI at the Chicago Bar Association, Chicago, Ill., Tuesday evening, March 7, 1961.

The panelists and their subjects were:

Plastic Films—Ralph Krueger, manager, Converter Sales, Film Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.
Extrusion Coatings—Arthur E. Irvine, market manager, Flexible Packaging, Union Carbide Plastics Co., New York, N. Y.
Non-Extruded Coatings—Warren C. Ashley, Technical Sales Pyroxylin Products, Inc., Chicago, Ill.
Molded Plastic Containers—John N. Scott, laboratory supervisor, Molding, Fabrication, & Filament Extrusion, Sales Service Dept., Phillips Chemical Co., Bartlesville, Okla.

Program chairman was Mike Hecht, Chicago Carton Co., Chicago, Ill.

Each speaker was asked to build his presentation around the following list of nine questions:

1. When was (plastic film, etc.) first used as a packaging medium? As what, developed by whom, for what product(s).
2. What was the packaging volume in 1950, what is it today (1960), and what do you anticipate it will be in 1970? If this information is available in chart form since its introduction (i.e., prior to 1950) so much the better. Please give, if you can, both the pound and dollar volume, for each resin type, and grand total; also, what per cent of the total volume of each resin type produced is used for packaging.
3. How is this volume split up—i.e., what are the specific end-use markets for each resin type?
4. What are the properties and economics of these that enabled them to capture the markets they have, and which will permit them to capture their markets of the future? What advances in polymer technology, engineering and processing know-how; what developments in packaging machinery; what changes in American distribution methods; what objective factors in the economy helped initiate and then spur and maintain the trend?

A description in broad terms of how the———————— are produced, as well as a broad description of how the basic raw material is made from what, would be of general interest.

5. What types of packages do these form—give pound, dollar, and unit, if possible—as used in conjunction with: alone, other films, flexible packaging in general, cartons, corrugated, solid fiber, paperboard in general, and what products are contained therein?
6. What packaging materials and what package forms did they displace in the market place? What per cent of the total was new usage, wherein no package had been used before?
7. What amount of paper and paperboard have they displaced on a tonnage and dollar basis in the past decade, and why? What do you project for the next decade?
8. What additional tonnage and dollar volume do you think have created for paper and paperboard, in what areas, and why? What breakthroughs do you see in the next decade?
9. What effort do you think is required by the paper industry, the paperboard industry, or the packaging machinery industry to most fully utilize the combined properties of the ————————and the delignified, matted cellulose fiber.

The Development of Plastics as a Packaging Medium—Keynote Comments

Mike Hecht

The pulp, paper, and paperboard industries measure their output in tons; the plastics industry in pounds. How long this relationship will continue, no one can say with certainty. What is certain, is that the plastics industry has increased its production many fold in the decade 1950–1960. Prices for most plastics, especially those enjoying wide use in

Mike Hecht, Chicago Carton Co., Chicago, Ill.

packaging, have fallen substantially. This decline in the price of plastics has corresponded with a rise in price of paper and paperboard, though they too registered considerable gains in production, 1950–1960. The net result has been that in some areas of packaging, plastics have displaced matted, delignified cellulose—where, and to what extent, and why, our speakers will in part illuminate. In other areas of packaging, plastics in combination with paper and paperboard, perform jobs better than either alone—again, our speakers will, we hope, tell us how, where, and why.

In the past few years, and especially in 1960, the folding carton industry and the packaging press, especially the segment most concerned with paperboard packaging, has discussed the question: "Plastics, friend or foe?"

Some, possibly many of you here tonight, have come here hoping to receive some kind of answer to this question. We have not asked our speakers to take a position on this issue, though some and possibly all of them have definite feelings on the matter and may wish to express them. Our purpose here is to inform and illuminate; our premise being the conveying of the facts, properly organized, will provide the best basis for understanding. To the extent this is done, will we provide a service to the pulp, paper, paperboard, and chemical, petrochemical, and plastics industries.

Others are here representing paperboard companies for whom the question: "plastics, friend or foe?" has already been resolved in part, at least, by the old adage: "If you can't lick 'em, join 'em." Continental Can, American Can, Container Corp. of America, Packaging Corp. of America, St. Regis, West Virginia, and I'm sure others, either have plastics subsidiaries or divisions. These, and other carton or paperboard producing firms—Fibreboard, International, Federal, Mead, Potlatch, Weyerhaeuser, and others—are engaged to a greater or lesser extent in research and development efforts designed to utilize plastics to upgrade their product and enable it to capture markets traditionally metal and glass. I think it would be fair to say there is not a major carton company in the United States, or possibly in the world, which is not engaged in this kind of activity.

Nor is this true only for paperboard and folding carton companies. St. Regis and Monsanto jointly developed Foam-Cor to utilize plastic foam instead of corrugating medium for shipping containers. Recently, the press reported our corrugated neighbor, General Box of Des Plaines, purchased a foamed plastics company, and just yesterday I read in the press Packaging Corp. of America did likewise. Some 5 years ago, lacquer coated, solid-fiber, multistrip beer containers appeared on the market, pioneered if I recollect correctly by River Raisin and Container Corp., and since then Mylar-laminated solid fiber and Mylar-laminated corrugated boxes have appeared on the market. Polyethylene bags or bottles in corrugated have, in areas, replaced metal cans or glass carboys for bulk milk and corrosive chemical shipment.

The paper industry, or more broadly, the flexible packaging industry, has felt the impact of plastics perhaps first and more emphatically than we in the paperboard, carton, and corrugated industries. Anybody who is anybody in the paper industry has for years been working with plastic coatings or slugging against plastic films—some times both simultaneously. There, even the janitors know all about polyethylene, and the cleaning ladies recite MVT rates and heat seal time-temperature-pressure relationships to each other when mundane gossip dulls.

Well known, but not too well recognized, is the fact that for many years polymers have been used by the pulp, paper, and paperboard industries to upgrade their products—wet-strength resins to do what the name implies; synthetic latex binders to clay coat paper and paperboard surfaces for improved printing; synthetic resins and film formers to form and fortify

1. Inks used to print paper and paperboard and
2. The varnishes and lacquers deposited over the ink to improve gloss, scuff resistance, water resistance, weather resistance, and a host of other appearance or functional characteristics.

There are two areas of plastics packaging which will not be covered on this program: (1) Expanded or foamed plastics and (2) thermoformed plastics, other than blow molded. As already indicated, it is not that we are unaware of them or their importance; there just wasn't time to fit them into an evening program. It is our intent, if this program is successful, to devote a program to foamed plastics in packaging next year, and if there is an interest, to thermoformed plastics in packaging the following year.

Plastic Films

Ralph Krueger

Over 30 different kinds of films, plastic and nonplastic, are sold in this country with the largest portion of the market in packaging uses, over 700 million lb. in 1960. The different outlets and the possibilities of further expansion are mentioned.

No matter how or by what means it is measured, plastic films, and cellophane is included in this broad definition, must be classed as big business—in pounds, in dollars, in types, and in the imaginative diversity of applications. This is a market which, in 1960, was measured at better than a billion pounds and in excess of two-thirds of a billion dollars!

In 1924 when du Pont first cast cellophane in this country, it was the only nonphotographic film on the market and it didn't achieve the then impressive million-pound annual use figure until it was two years old. At the close of World War II, the film family had expanded to about ten members, and at my last count a few months ago—probably already outdated—no less than 30 different films were being sold in this country.

Most of these are plastic films—made from high polymers—and the roster includes polyethylene, polypropylene, polyethylene terephthalate, rubber hydrochloride, polystyrene, polyvinyl chloride, polyvinylidene chloride, polyvinyl fluoride, polyvinyl alcohol, the fluorocarbons, and others. There are nonplastic films, of course—cellophane and the cellulosics, for example—and it is inevitable that we talk about these to some extent—not only because they share the market but because, from a practical standpoint, it is often difficult to pry them out of the statistics.

Another statistical difficulty lies in the distinction between film and sheeting. Ten-mil thickness is generally considered the breakpoint, with material up to and including this thickness considered film and anything above that figure considered sheeting. Sheeting consumption often finds its way into film totals, and because of this and other complications it is difficult to find any two sets of data about this business that agree.

Like most of the industry, we look at two categories of applications—packaging and industrial, with the latter term really meaning nonpackaging and covering a tremendous variety of uses.

It is in the packaging side of the market, of course, that transparent films have made their biggest penetration from the standpoint of both volume and percentage. Films were first conceived of and developed as packaging materials. Their advantages were obvious. Visibility plus protection plus ease of application at moderate cost constituted a formidable set of selling tools for the salesmen who descended on the packagers. Thanks to these virtues, transparent films and self-service shopping are in something of a chicken-and-egg relationship. Which came first is hard to determine,

Ralph Krueger, Manager, Converter Sales, Film Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.

but it is certain that the growth of each has relied heavily on the other.

At any rate, the consumption of transparent packaging films in 1960 was well in excess of 700 million lb., with the plastics playing second fiddle in this market to the older, but still vital, cellophane. Polyethylene's slice of this business was about 210 million lb., cellophane's over 440 million, and the balance divided up among the half-dozen or so plastic films that occupy specialized niches in this market. Their share of the film business in 1960 was about 10% and it will probably stay close to that in 1961.

Overwrapping takes the lion's share of the packaging poundage with smaller quantities going into bags and other converted forms, and much smaller volume into such specialties as skin and blister packaging. Cellophane, with its smooth machine performance and excellent package characteristics, dominates the overwrapping field. Over one-third of the white bread in the country is now wrapped in cellophane, for example, and the percentage moves continuously higher. Polyethylene film is used primarily in bag form.

Almost from the start, the food industry has been the leading consumer of packaging films and about 70% of the production still goes in this direction. The largest nonfood market for the plastic packaging films is textiles, which uses more polyethylene—about 40 million lb.—than any other single commodity class except fresh produce, which consumed almost 75 million lb. in 1960. Incidentally, over 95% of cellophane is used for packaging, while only about 70% of the polyethylene film produced goes into that market.

Now, let us look at the present state of the nonpackaging films market.

It is obvious to everybody that films are becoming increasingly important as product components, in processing, and for other uses—like fabric replacements, for example—that don't involve the package. An industry that a decade and a half ago was almost totally involved in the food business, and a few other packaging areas, is now looking at a much wider panorama and, in general, it likes what it sees.

In tonnage—and in dollars—this segment has sprouted to half the size of its packaging counterpart, and this year will absorb about 400 million lb. of film in products ranging from capacitors to football field tarpaulins.

About ten major film types compete for this business—and compete rather vigorously, I might add. Polyvinyl chloride and polyethylene are by far the biggest factors, accounting between them for about two-thirds of the volume. The remaining one-third is shared more or less evenly by the other competitors.

The 400 million lb. go into applications that can be divided up into the following categories, listed according to size: (1) Fabric Replacement; (2) Construction and Agriculture; (3) Pressure-Sensitive Tape; (4) Laminations; (5) The Rubber Industry where films are used as separator sheets; (6) Disposable Covers; (7) Surfacing, both protective and decorative; (8) Stationery Supplies; (9) Roll Leaf; (10) Reinforced Plastics; (11) Electrical and Electronic; and (12) Magnetic Tape. A "Miscellaneous" category gathers up dozens of uses, all small but collectively fairly important and, hopefully, the embryos of some future major outlets.

The first two categories bulk quite large and soak up something over one-third of the total tonnage. The remaining two-thirds is divided rather evenly among the other markets, with no single area outstanding, with the exception of Miscellaneous which is quite high.

Most of the categories are fairly self-explanatory, but the list is worth studying, I think, since in its diversity, and in the potential size of the markets in each category, lies the secret of the great opportunity we see ahead for film.

There is a product that is being used in ladies' lingerie and in the stators of hard working electric motors, in liners for farm ponds, and in high-altitude balloons. Altogether, we find a market with a broad base and one in which film has earned its place.

Film has made its way so far because it alone makes a product or a process possible, or because it improves a product or a process, or because it reduces material or labor costs. The last of these three virtues is naturally the most compelling one and, since it is probably the most commonplace one as well, it offers high promise for the future.

Films have their competitors—paper, cloth, rubber, foil, metals, plastic resins, fibers, glass, and so on down practically the entire list of commodities. But they compete with each other as well. In many markets, alternative films with different performance and price levels are available: polyethylene, polyester, vinyl chloride, and polyvinyl fluoride can all be used for glazing; polyethylene and polyester for electrical insulation; polyethylene and vinyl chloride for fabric replacement.

But the internal competition is not always quite as great as it seems on the surface. Films are not as interchangeable in some industrial markets as they are in packaging, because end uses often demand more specific properties or different price levels. There is room for many films and those that are midgets in volume are often as successful in their way as the giants are. Volume is determined not only by how good the product is and how well it performs at low cost, but also by the size of the market in which the film is functional and economic. The demand for a film with a high-temperature operating level of 400° is never going to approach that for plastic tablecloths.

So much for the present state of the business.

In the packaging field we believe that transparent films are inevitably going to grow and that they are certain to reach the billion-pound level by the mid 1960's. Everything points to expansion. The packaging industry, like every other aspect of the economy, is going to ride the high tide of a 3 million-per-year population increase. The rising purchasing power of the average consumer will make him more demanding about what he buys, including the way it is packaged and, I think, there is no question about the buyer's growing interest in convenience, particularly in foods. And convenience, more often than not, means packaging. Add to these factors the competitive push to better packaging, and the fact that films often supply it best, and the conclusion that packaging films will expand tremendously is inevitable.

Although the plastic films will grow faster, cellophane will increase in poundage, too, and will continue to be the largest single film in the field. Biggest plastic film is, and will be, polyethylene which, together with cellophane, will account for about 80% of the total market in the mid '60's. The film business being what it is, however, I, like any other forecaster, can be left out on a limb in the next few years if a great new film comes along, or if any existing one suddenly spurts ahead because of some factor we can't now see.

If the history of films is any guide at all, it is certain that there will be new film types and major modifications of some of the old standbys. It would be easy for me to predict what they will be like. I would just jot down the areas in which present films are deficient and say that the new ones will have the characteristics now missing. You can do that as well as I, of course, and I'm going to limit my predictions to the safe statement that new films are going to open up still more packaging markets. Some of that is going on right now, particularly in the area of film combinations. Laminated and coated films for vacuum and gas packaging are threatening cans and other vacuum packs already. "Boil-in-the-bag" packaging, a film development, has introduced a whole new concept to the food processor and, although this market is just beginning to shape up, I don't think it is daring to predict that a few years from now annual sales of these units will be in the billions.

The spread of self-service, with its emphasis on good packaging and, in many cases, on transparent packaging, is

going to spread even farther than it has now. Variety stores are shifting to it, department stores are moving in that direction, and even in the hardware store these days you need the clerk only to take your money. There could hardly be a more significant development for the film industry.

Regardless of how bullish our outlook for packaging films is, we believe that the market for industrial films will expand even more rapidly.

Film has been accepted as an engineering material—not everywhere, of course, but widely enough to make future market penetration easier. For example, the long years of skeptical testing of the film concept by the electrical industry is over. Films are commonplace components in many electrical devices. Individual types will have to prove their worth, of course, but the film idea is accepted.

Designers are beginning to understand films and how to use them effectively, particularly to cut costs, and they now have in their catalogs a range of films that is wide enough to ensure that specific properties for an application can be obtained and at costs that are commensurate with the level of properties required.

A few years ago films were being made largely for packaging applications, and if a material that was designed for wrapping bacon happened to have good electrical properties, that was a bonus on which the manufacturer tried to capitalize. More recently, films have been engineered from the start for industrial uses and, as a result, many of them offer a balance of properties that solves several design problems at one swoop. New developments, in the form of new films and modifications of existing films, are going to make this an even more important aspect of the business.

Let me cite an example from our own work.

Late in 1960, du Pont announced construction of commercial facilities at Buffalo, N. Y., to produce a new film called "Teslar"* PVF film. "Teslar is a new plastic which has resulted from the company's research into fluorine chemistry initiated in the early 1940's. The unique properties of this new film include outstanding weatherability, toughness, chemical inertness, and ease of fabrication. Teslar will be produced in a fairly broad range of types and gages; in pigmented as well as in transparent form; in thicknesses ranging from $^1/_2$ through 4 mils; and, in glossy as well as satin finishes.

Teslar is expected to find application as a prefinishing medium for metals which are subsequently formed into industrial and commercial building siding and roofing. Combined with other materials, such as glass and asphaltic substrates, it will provide a new type of roll roofing. It will be used as a prefinishing medium for plywood, hardboard, cement asbestos and asphalt impregnated insulation boards to produce new tough and weatherable building panels of all types. Teslar and Teslar laminates will find application as weatherable decorative and protective covers on thermal insulation materials.

Outstanding weatherability is one of Teslar's real contributions. Early research samples have been weathered in Florida for over ten years and are still tough and transparent. In comparing this new film with other plastic films, it should be noted that unplasticized polyvinyl chloride film fails after 6 months in Florida, that low density polyethylene fails after 3 months in Florida, and that "Mylar"* polyester is good for only 3 to 6 months.

In comparing the life of Teslar PVF film as a finish on metals such as aluminum and galvanized steel, and on building boards such as hardboard and plywood, our tests indicate that it will have three to four times the life of finishes such as the alkyd enamels, nitrocellulose enamels, and acrylic lacquers.

In expressing toughness, abrasion tests on it in comparison with other finishes, such as acrylic lacquers and appliance enamels, are quite revealing. It shows up five to ten times better!

Techniques for commercial application have been worked out and we expect the applied price to fall in the $3^1/_4$ to $6^1/_4$¢ per sq. ft. range. In Teslar we have the first real all-purpose outdoors finish which, in many areas, will replace conventional paints and lacquers and open up entirely new markets for prefinished building and construction materials.

In view of these facts—in addition to the general economic outlook for the next decade—we believe that the industrial market for films will double by 1965 or a little thereafter, reaching a 600-million lb. annual rate. Polyethylene, polyesters, and vinyls will lead the way, accompanied, I am sure, by some of the newer films that will come along. Key markets in this tremendous growth will be construction and agriculture, including glazing; electrical and electronic, surfacing, and magnetic tapes.

Additional break-throughs, of the kind I mentioned previously, can move this figure considerably higher, particularly if they result in lower prices. Since a cost advantage, based on either material or labor savings, is the principal wedge for opening any film market, every drop in prices opens a whole new array of applications for films. Our polyester film, trade marked Mylar, is a case in point with its steadily declining price curve accompanied by a volume line moving in the opposite direction.

All of which leads me to believe that a continuance of the film industry's historical price reduction curve will create tremendous new volume and put films into new markets where they have no place today.

One further word about new films. We believe that there will be many of them and that they will have interesting and valuable properties. We are firmly convinced, however, that there will never be an "all-purpose" film in either the packaging or industrial markets. The strength of the business lies in the fact that the product line provides specific properties for specific applications at specific price levels. This is accomplished only by building specific films for the job and, we believe, that the future is going to expand the line rather than produce a single material that is all things to all men.

* du Pont registered trademark.

Polyethylene Extrusion Coating—How Is It Doing? Where Is It Going?

A. E. Irvine

The development, techniques of application, and advantages in the use of polyethylene extrusion coatings are described.

Eleven years ago reviewing the status of the polyethylene extrusion coating industry—How is it doing? Where is it going? would have been a pretty easy job. Actually, it would have been found hard to dispute what could have been said then. Of necessity, the talk would have been "blue sky"—projections into the future. Who could say these projections would or would not come true?

Extrusion coating was an infant industry in 1950. Published accounts of the industry's birth tell of H. P. Smith Paper Co.'s development of the Loxol coating process, made commercial in October, 1948. Basically, this process consists of extruding resin into the nip of two steel rolls, one of which turns and carries the substrate. The other roll, which is stationary, applies high shear to the molten resin, controlling the amount of coating applied. In July, 1949—after 2 years of cooperative work with du Pont—St. Regis Paper Co. announced a commercial extrusion coating operation at its Oswego, N. Y., plant that is essentially the same as the extrusion coating process we know today. International

A. E. Irvine, Market Manager, Flexible Packaging, Union Carbide Plastics Co., New York, N. Y.

Presented at the meeting of the Chicago Section of TAPPI, held in Chicago, Ill., March 7, 1961.

Paper Co. reports that its coating setup got going at about the same time.

At the start of the Fifties, therefore, H. P. Smith, St. Regis, and International were the only companies with commercial extrusion coating facilities. There were only two suppliers of polyethylene resins in the United States—Union Carbide and du Pont. The few resins available were adapted for extrusion coating rather than developed specifically for it.

Today, reviewing the status of this young, dynamic industry is more difficult. The industry has become a 55 million lb. a year user of polyethylene. The list of resin suppliers serving the extrusion coating industry has grown to 13. Union Carbide alone now has a published list of 16 polyethylene products tailored for extrusion coating, not including those in various stages of development. About 50 companies now are actively engaged in extrusion coating. And, many of those "blue sky" ideas of 1950 have become commercial relatives today.

There is *still* a lot of "blue sky" left in extrusion coating. Fifty-five million pounds of polyethylene is a small amount compared to what the volume could be if certain markets break.

The paper industry and the plastics industry are both counting on these breaks to come. This confidence in the future is reflected by steadily increasing capacities in each industry. Our figures show that during the past year extrusion coating capacity has risen about 50% to approximately 100 million lb. of polyethylene annually. Expected increases in extrusion coating uses also figures prominently in the highly publicized capacity increases for the polyethylene resin industry.

In 1960, the extrusion coating industry as a whole operated at roughly 60% of its capacity. This situation is not critical as yet—nor will it be—if markets develop as they now promise to. In fact, need for *new* capacity should arise.

If those who are well versed in the art of extrusion coating will permit, I'd like to take a few minutes here for some fundamentals. This, I hope, will help those of you less familiar with extrusion coating to better understand what is discussed later.

Fundamentally, the technique is the direct application of an extruded molten film of resin against a substrate as it passes through pressure rolls. Hence, it is sometimes referred to as extrusion lamination. Extrusion coating equipment is specialized. It generally consists of large, long-barreled, electrically heated extruders and flat film dies with heavy duty unwind and windup equipment.

In a commercial extrusion coating operation the substrate is passed into the nip of two rolls, where it comes in contact with the hot film from an extruder. Pressure is applied by the rolls to achieve the marriage of the film and the substrate. One roll is a water-cooled metal roll called a chill roll which solidifies the polyethylene. This roll is driven at controlled speeds to draw the extruded film to the desired thickness. The other is a rubber-surfaced pressure or "back-up" roll with controllable pressure. Trimmers are used to remove the edge of the coated material to produce a flat, uniform sheet. From the trimming operation, the coated stock is wound into rolls and is ready for converting.

The more common coating operations involve web widths of 3 to 6 ft. with speeds ranging from 250 to 800 f.p.m., and coating thicknesses from $^1/_2$ to 2 mils. These gages, incidentally, represent coating weights of $7^1/_4$ to 29 lb. of polyethylene applied to 3000 sq. ft. of substrate. These coating widths and thicknesses, however, are not all inclusive. Coatings are applied in widths as high as 10 ft. and in thicknesses as low as $^1/_4$ of a mil and as high as 5 mils.

There are definite functional advantages of polyethylene which can be used to complement those of the substrate, whether it be paper, paperboard, film, foil, or cloth.

As a paper coating, polyethylene complements the stiffness and ready machinability of paper by adding heat sealability, moisture and chemical resistance, before and after creasing, and good release characteristics. For example, as a barrier ply in multiwall bags, 1 mil of low-density polyethylene has almost double the moisture vapor resistance of a 30-30-30 asphalt laminated kraft construction. Increase the resin density, and you have even greater protection. Release characteristics of a polyethylene coating are highly desirable in paperboard packaging of items which tend to stick, such as frozen foods and baked goods. They are also important for paper and cloth used for pressure-sensitive tape backings.

Applied to aluminum foil, polyethylene gives heat sealability, tear and puncture resistance and fills in the pinholes of very thin gage foil. A package made of polyethylene-coated foils gives you what might be called a "flexible tin can." You have an outstanding moisture and grease barrier *plus* flexibility.

Added moisture protection is the prime reason for coating cellophane with polyethylene. You also get improved heat sealability and tear strength. Result—a tough, high clarity, moisture, grease, and gas resistant packaging material.

Of the 55 million lb. of polyethylene used in extrusion coating in 1960, paper and paperboard consumed over 65%. Putting this in the terms of your industry, about 73 thousand tons of paper and 40 thousand tons of paperboard were coated with polyethylene last year. Compare these figures to those of only seven years ago. At that time, 12,000 tons of paper and a mere 350 tons of paperboard were coated with polyethylene.

Just what effect have polyethylene coatings had on the paper industry's business? This is a tough one to pin down in terms of tons or dollars and cents. Certainly, though, there are areas where a polyethylene coating has helped paper gain new business. For example, polyethylene-coated multiwall bags are used for products which require high moisture protection and also where resistance to fiber contamination is needed. Other prominent examples include pouches for tobacco and dehydrated foods. In addition, polyethylene coatings have helped paper do a better packaging job in sugar packs, food pouches, bread wraps, and many other applications.

As for the future, there is every indication that polyethylene coatings will help increase paper's role in areas now dominated by nonpaper materials, such as glass and metal.

The outlook is bright for coated paper, also for cellophane, polyester film, foils, and combinations. But paperboard shows the greatest growth potential of all. Based on expected increases in the use of polyethylene coatings on food grade board and other board stock, it can be estimated that somewhere in the neighborhood of 500 thousand tons of paperboard will be coated with polyethylene by 1965. This would represent 45% of the polyethylene used for all extrusion coating. Candy and bakery boxes, milk containers, general dairy products, dry and granulated powder products, frozen foods, and hot drink containers are all areas where polyethylene-coated paperboard offers many important advantages.

The big immediate market, of course, is the milk container. Wax-coated board cartons have already gained more than half this market, but there is every indication that paper's share of the market will continue to expand. Polyethylene coatings will provide the needed stimulus.

This type of carton eliminates several of the gripes about wax-coated paper milk containers. Top protection is provided against leakage, flaking of the coating, and damage from handling. Look for paper to take more of the milk container business—with the help of polyethylene.

A major breakthrough as far as the future of polyethylene-coated paper and board is concerned is the commercial use of glueable, printable coatings. The fact that, by treating, polyethylene-coated surfaces can be glued to uncoated paper surfaces with conventional packaging glues on commercial

gluing equipment opens the door to completely new application areas. Polyethylene-coated board can now be used in packages where it was never used before because of slow heat sealing speeds. Result—the paper manufacturer can offer customers and prospects a new and improved product at little or no increase in cost, and possibly even a cost saving.

Just think of the possibilities in polyethylene-coated single-wall packages. Cereals, frozen fruits and vegetables, dry foods—all could conceivably be packaged in polyethylene-coated paperboard cartons. Other potential markets—frozen juice concentrates, frozen soups, and whole juices. Perhaps even products such as premixed pancake and waffle batters.

Shipping containers is another area. For example, a lot of fresh produce is shipped hydrocooled or top iced. So is poultry. At present, wooden crates, not corrugated cartons, are the standard containers because the moisture would soak through and weaken the unprotected corrugated board. A lightweight polyethylene coating could make the difference. Corrugated already has economics on its side.

One application already on the move is polyethylene skin packaging. It started in the ceramics industry and spread to the electronics and aircraft industry. Now, the household moving industry is using it and department stores are looking at it very closely. Very briefly, the process is the forming of a tight film over items positioned on a polyethylene-coated paperboard. The coating is needed for adhesion. It is a functional shipping package that should broaden the use of polyethylene-coated corrugated board.

Liquid-tight packages—coated paper, foil and combinations all have a place here—also promise additional growth for paper in the packaging industry. It's the polyethylene, of course, that gives you the liquid-tightness.

Let me take you back to 1950 once more. In its young life, the extrusion coating industry has experienced a veritable equipment revolution.

In the early fifties, a typical extruder used in the coating operation had a barrel 66 in. long. Now, a typical extruder barrel is 120 in. long, and the largest extruder barrels measure up to 168 in. in length. Die size has also increased. Fifty-four inches was a common size eight or ten years ago compared to 72 in. widely used today. They can go much bigger.

The big difference in equipment can be seen most clearly by comparing the resin throughtput capacities of today's extruders with those of 1950. Then, a resin throughput of 300 lb. per hr. was a good rate. Today, throughput rates of 1000 lb. per hr. are used and up to 2000 lb. per hr. are obtainable. Expressing this in terms of a 1 mil coating, we are comparing 60,000 sq. ft. per hr. with 400,000 sq. ft. per hr.

Speeds have also increased tremendously. In the early fifties, 150 f.p.m. was good coating speed. Some of today's machines are capable of 1000 f.p.m., depending on web width and coating thickness. This high-speed equipment has been on the market for a couple of years, but not until recently have resin manufacturers come up with materials that could achieve the speed levels possible with these new machines. Coating resins are now available that can be run at speeds in excess of 800 f.p.m. in coating weights as low as 2 to 3 lb. per ream.

A driving force for many potential uses of polyethylene-coated products is the snowballing trend to convenience among consumers. Today's busy housewife wants a package that saves her time and does not put her in danger of breaking a fingernail or cutting her hand. Polyethylene-coated packages—by eliminating a liner, on overwrap or metal ends—certainly befriend the housewife.

One notable example is the "Fibrematic" cartons now used by leading frozen food companies to package frozen strawberries. The package consists of a paperboard carton with a polyethylene-coated paper liner and an easy-to-open top. It eliminates the mess, annoyance, and the tough-to-open dangers of a metal-end container.

Still another brand new package is a paperboard carton, coated on the outside with polyethylene, for free-pouring individually quick frozen vegetables. It has an easy-to-open easy-to-close top. This certainly is one possible means of maintaining your market position through an improved container.

In evaluating polyethylene coatings for your markets, you in the paper industry must consider these two things:

1. Can polyethylene coatings help you maintain your hold on certain markets which may be threatened by other packaging materials?
2. Can polyethylene coatings help you increase your penetration in markets now dominated by non-paper materials?

The developments and potentials just reviewed indicate that polyethylene coatings can do both these jobs in many areas vital to the future of the paper industry.

Your chairman asked me to comment on what efforts are required of the paper industry in the extrusion coatings area.

There is, of course, a lot of work to be done. For example, the need for educating personnel on the fine points of extrusion coating. A greater number of qualified experts on the subject among the paper industry's technical and sales personnel is essential.

Further machinery improvements, both in the extrusion end and the converting end of the operation, are needed and can be expected. So too, new resin developments will be needed to keep pace with your demands. The paper industry can contribute to these needs by definition of new requirements.

Market development is at this point a vital job. If polyethylene-coated paper and paperboard are to fulfill their potential, it will require the combined efforts of paper, plastics and machinery people. The challenge we face is formidable, but I firmly believe that polyethylene extrusion coating is on the threshold of new horizons. Polyethylene coatings should play an increasingly important part in the packaging industry and in complementing the many outstanding products of the paper industry.

Plastic Coatings and Packaging

Warren C. Ashley

A plastic coating, in its elemental state, is a film-forming macromolecular material which can be classified according to their basic constituents, the method of application, or their principal functional property. An outline is given of the various applications of primary importance, including hot melts.

A PLASTIC coating, in its elemental state, is simply a film-forming macromolecular material. The word plastic is used advisedly in order to emphasize the fact that it makes little difference whether the material is formed from a molding powder or cast from solution, the material is still a plastic. However, as pointed out in the definition, a plastic to be useful as a coating must be a film-former.

The ability to be a film-former suggests a decided degree of toughness and strength in the compound, thus paraffin wax can scarcely so be classified whereas polyethylene, a very close relative of paraffin, is not only a film-former but, depending on type, can be most proficient in this respect.

Chemically speaking film-formers are most usually built up from carbon, hydrogen, oxygen, and nitrogen. Some contain a certain (sometimes considerable) amount of chlorine or

WARREN C. ASHLEY, Technical Sales, Pyroxylin Products, Inc., Chicago, Ill.

Presented at the meeting of the Chicago Section of TAPPI, held in Chicago, Ill., March 7, 1961.

sulfur. At best only about ten of the currently known 102 elements are ever represented in a plastic coating.

Probably without exception the plastic coating is applied to paper, or whatever, for one or more specific reasons. These reasons prescribe certain physical properties for the plastic coating so that in the majority of cases the inherent physical properties of the film-former will be modified. Common modifiers are the resins, plasticizers and additives. The application conditions modify the character of the coating and in the case of lacquers the solvent system plays an exceedingly important, but seldom recognized role, in determining the physical properties of the deposited film.

Plastic coatings can be classified according to their basic film-former. Without attempting to be complete such a list would include: nitrocellulose, other cellulose derivatives, vinyl co-polymers, substituted vinyl polymers, chlorinated rubber, acrylic, phenolic, alkyd, epoxy, urethane, and amine. A large number of variations of all these types are available, e.g., nitrocellulose is available in various degrees of nitration and in numerous intrinsic viscosity grades.

The method of application can with equal authority be used as the basis for classification of plastic coatings. Main headings for such a list might identify plastic coatings as: brushing, dipping, flow-coating, tumbling, roller coating, spraying, gravure, flexographic, and silk screen. Subheadings might reflect the means for eventually setting up the plastic film, terms such as: air dried, air cured, force dried, baked, and catalyzed.

Plastic coatings are classified according to their principal functional property, as: water repellence, moisture vapor resistance, gas barrier, solvent resistance, chemical resistance, grease resistance, heat-seal, nonheat-seal, gloss, and scuff resistance.

The highly viscous tough plastic in the plastic coating cannot be applied as is; the plastic must be transformed into a physical state capable of being deposited in a satisfactory manner. Independent of all other considerations a classification for plastic coatings based on physical state at the point of application might be as follows:

Fluidized—discrete particles suspended in a gas.
Latex—discrete particles suspended in water.
Plastisol—discrete particles suspended in plasticizers.
Organisol—discrete particles suspended in plasticizer and nonsolvent.
Lacquer—plastic coating in true solution.
Varnish—components of plastic coating in true solution.
Hot-melt—solid liquefied by heat alone, medium viscosity.
Extrusion—solid liquefied by heat alone, high viscosity.

After some mention of the dollar value and the gallon volume of the coatings industry this discussion will be limited to latices, lacquers, varnishes, and hot-melts as they are used in the paper converting field.

Record sales were enjoyed in 1960 by the paint industry with a total production of about 670,000,000 gal. worth $1,782,000,000. The industry is represented by about 600 paint companies (20 or more employees) with an average total employment of about 60,000 employees. One of the anomalies of the protective coatings industry is, the better the product the less the demand, in other words, good paint lasts longer than poor paint. Even so the rate of growth is about normal for the economy.

In this era of rapid technological advancement it is not amiss to point out that the technical side of protective coatings is represented by the Federation of Societies for Paint Technology, with 25 local societies, and 4000 active members.

Table I. Breakdown of Paint Sales for 1960

	Gallons	*Value*
Trade sales	346,900,000	$1,036,700,000
Industrial	321,800,000	745,300,000
Paint and varnish	240,800,000	545,200,000
Lacquer	81,000,000	200,100,000
Total	668,700,000	$1,782,000,000

In these figures from the Bureau of the Census, lacquers and varnishes used in the packaging industry are classified as industrial sales. No attempt is made to breakdown totals as to specific end-uses. In addition to these amounts large quantities of coatings for paper converting are derived from sources outside the coatings industry, for example, the printing ink manufacturers and paper converters themselves. And furthermore materials used that are not even considered as coatings and therefore also not in the above figures are latices used as adhesives or binders, hot-melts and inks (colored coatings).

Speculative inference and rumor can be used to estimate the disposition of plastic coatings as to end-use. The applications for the three types of plastic coatings given in Table II are arranged in the order of relative importance.

Table II. End-Uses for Solvent, Hot-Melt and Latex Plastic Coatings

	Solvent	*Hot-melt*	*Latex*
	Furniture	Cheese wraps	Paint
	Automobiles	End seals	Paper:
	Metal	Modifier for paraffin	Impregnating
	Coated fabrics		Priming
	Cellophane	Heat-seal labels	Sealing
	Paper	Bookbinding	Clay coatings
	Foil	Bag sealing	Textiles
		Bag saddles	Adhesives
		Carton closing	
		Strip coatings	
Production 1960	68,000,000 gal.	5,000,000 lb.	75,000,000 gal.
Packaging, % used in	10	85	1

In Table II under solvent coatings only clear varnishes and lacquers are included since very little if any pigmented or enamel coatings are used in packaging. The total for clear solvent coatings is made up of about 30,000,000 gal. of clear varnish and 38,000,000 gal. of clear lacquer. It is interesting to note that the production of clear varnish is decreasing while the production of clear lacquer is slowly increasing.

As recent as 1954 all clear varnishes were combined into one total by the U. S. Department of Commerce but in 1958 (last report) clear varnishes were broken down into classes—alkyd, epoxy, polyester, etc. Clear lacquers based on nitrocellulose are still predominant (about 77%) in the lacquer category. The production of nitrocellulose and other cellulosic lacquers remained fairly constant from 1954 to 1958 whereas the production of lacquers based on other film-formers increased about 300%.

Nitrocellulose lacquer is probably the only type of finish for which reasonably accurate end-use information is available. Nitrocellulose lacquers, known and used for over 35 years, have found many varied applications. These applications are well known to the trade and to the suppliers of the basic lacquer grades of nitrocellulose.

An independent survey has estimated on a solids basis the disposition of nitrocellulose in lacquers which were produced in 1958 as follows:

	%
Furniture	22
Automobiles, new	10
Automobiles, refinishing	10
Coated fabrics	18
Cellophane	12
Paper and foil	5
Metal and industrial maintenance	5
Inks	4
Miscellaneous	14
	100

The relative importance and the various end-uses are estimated to be essentially the same in 1960. In this discussion we are interested only in the use of lacquers on cellophane, paper, and foil. Very thin films are applied on cellophane and aluminum foil, as compared to coated fabrics, for example, thus much greater areas of surface are coated in these applications than would be indicated by the weight-per cent distribution figures given above.

Cellophane was introduced to this country in 1924. In 1927 cellophane was coated for the first time with moisture vapor resistant nitrocellulose lacquers and today about 85% of all cellophane is coated with either a nonheat-sealing or a heat-sealing type of moisture vapor proof nitrocellulose lacquer. The production of coated cellophane for packaging increased by about 25% from 1954 to 1959; the 215,000 tons produced in 1959 consumed about 7,000,000 gal. of lacquer. During this same period polyethylene film for packaging increased by over 200% but not at the expense of cellophane.

A Hercules Powder Co. survey on the use of nitrocellulose lacquers as paper coatings established the fact that a minimum of 3,000,000 gal. of nitrocellulose lacquers are consumed per year for packaging purposes.

The largest single kind of paper coated with lacquer is glassine. In contrast to most papers the smooth nonporous surface of glassine presents the ideal coating surface for plastic coatings. Glassines are lacquered to produce maximum transparency and gloss and to provide moisture vaporproofness, water repellant properties and positive heat-sealing qualities. The inherent properties of glassine may also be improved. Other papers and some boxboards are coated with nitrocellulose lacquers, and other lacquer and varnish coatings, for numerous functional reasons. In contrast to glassine the surface of the paper, either sheet or board, must first be made nonabsorbing and as smooth as possible before coating.

Paper varnishes based on natural resins (spirit varnishes) and on synthetic resins (naphtha varnishes) are only pseudo-varnishes because the resin ingredients used are not inherently film-formers. It was not until about 1948 that the first true paper varnish made its appearance. Based on styrenated alkyd resins and set up by heat and catalyst the finish derived therefrom was definitely a plastic coating. Several catalyzed varnishes now are available. Typical of varnishes their dominant characteristic is high gloss and depth of gloss and their inability to excel in most all other functional properties limits the use of catalyzed varnishes to applications where gloss is the controlling factor. While the consumption of this class of clear varnishes is growing the rate of increase has not been sufficient to make up for the over-all general decline in production of clear varnishes.

The total production of aluminum foil in 1959 was about 265,000,000 lb. Flexible aluminum foil for some kind of packaging amounted to about 75,000,000 lb. and part of this was coated or printed or both. Very thin aluminum foil laminated to paper provides an excellent printing and coating surface to the paper. Nitrocellulose lacquer is the principal foil coating especially for colored foils. Vinyl lacquers for foil are used for their protective and heat-seal properties. Flexographic and gravure inks for use on aluminum foil are based on nitrocellulose lacquers.

An understanding of the term hot-melt, at least as it applies to this discussion, should be reached before proceeding. One definition of hot-melt hinges on the per cent modification of paraffin wax, a definition which seems to serve no useful purpose. By some any solid at room temperature, like paraffin, which is liquefied by heat for application, is called a hot-melt; this definition overlooks the fact that paraffin wax and waxlike substances were in use for a long time before it became necessary to coin the word hot-melt. Hot-melt originally referred to a *plastic coating* which for application purposes was liquefied with heat alone. This original conception of hot-melt as a distinctive new type of plastic coating can be maintained if:

1. The term hot-melt is reserved for those materials which:
   (a) Are applied in a molten condition at temperatures in the range of 250 to 375° F.
   (b) Have appreciable molten viscosities at the point of application.
   (c) Require special equipment for application.
2. The terms wax and modified wax are reserved for those materials which:
   (a) Are applied at waxing temperatures or in the range of 180 to 220° F.
   (b) Have very low viscosities at the point of application.
   (c) Require only regular waxing equipment for application.

The 1,000,000,000 lb. of paraffin used in packaging in 1960 was not included by definition in Table II under hot-melts. However large quantities of concentrates (wax additives in mineral wax), which undiluted have the characteristics of hot-melts, are used for modifying wax. It is estimated that at least half or 500,000,000 lb. of wax is modified to some degree.

The largest single use for a hot-melt is probably as a protective and heat sealable coating for cheese wraps. It is estimated that the consumption for this use in 1960 was of the order of 1,500,000 lb. In 1960 an estimated 1,000,000 lb. of hot-melt was used as a heat-seal coating for end seal labels, 1,000,000 lb. as concentrates for modifying paraffin and microwaxes, and another 1,000,000 lb. for heat seal labels. Hot-melts are used, in contrast to other plastic coatings, almost exclusively in some form of packaging; bookbinding and strip-coating are two important exceptions.

Hot-melts are usually applied to a substrate and then at some future time used for their heat-seal properties. Under these circumstances hot-melts, like heat-seal lacquers, are definitely coatings. But in recent years more and more hot-melt is being applied and used as an adhesive in a continuous operation; when used in this manner hot-melt adhesive is a more descriptive designation.

About 48,000,000 gal. of latex out of the 75,000,000 gal. produced in 1960 was consumed in the fast growing field of water-based paints. However, latex plastic coatings have practically no applications as surface coatings in packaging; they are not even listed as coatings in the "Modern Packaging Encyclopedia."

While latices have little direct interest for this discussion they are important to the packaging industry. Latices by themselves and in combination with the usual binders are used to up-grade paper and to prepare the surface of paper and paper boards for printing and plastic coating. Latices in clay coating formulations lowers the viscosity and thus permit high solids levels and heavier coating weights. The effects on the properties of the clay coated paper, among other things, are more uniform ink receptivity and better plastic coating holdout.

Latices are also very important as adhesives in the packaging industry for a variety of uses. Their consumption as adhesives has increased over 300% in the past ten years.

FUTURE DEVELOPMENTS

The accelerated rate at which improvements and additions are being made in the plastics industry is common knowledge. Perhaps from past experience and current knowledge the directions future developments will take can be anticipated. These changes will certainly affect the plastic coatings used in the packaging industry.

The influence of molecular structure on the physical properties of a polymer can be illustrated with natural rubber. The *cis* form has the soft, flexible, elastic characteristics of rubber whereas the *trans* configuration is tough and hornlike; while identical chemically one isomer is rubber and the other gutta percha or balata. Heretofore synthetic rubber could be used to replace only about half of natural's uses but in late 1961 Goodyear Tire & Rubber Co. is expected to go on

stream with a stereospecific polyisoprene which is the test tube equivalent of natural rubber and is considered a complete substitution. It is reasonably safe to predict that the stereospecific polymerizations will provide polymers with characteristics not now available.

In the copolymerization of two components into a chain the components may alternate in a more or less regular fashion or, on the other hand, the components may alternate in a random way. The techniques of block polymerization have been used for some time to control the distribution of the components in the main chain of a macromolecule. In addition the trunk chain can be modified in a predetermined manner by grafting side chains of varying kinds and lengths. Block and graft polymers containing as many as five components have been prepared; the macromolecules produced have unusual combinations of properties with respect to adhesion, surface activity and passivity. The whole field is expanding rapidly.

A plastic coating is customarily formulated by physically blending a film-former with a judicious choice of modifiers. The end result is a more or less unsatisfactory compromise. Formulation by chemically blending the components is a far better way to design a plastic coating since the film becomes a single component macromolecule. Polyvinyl chloride is plasticized and made relatively soluble by copolymerization with vinyl acetate, and polyvinyl acetate is internally plasticized by copolymerization with its plasticizer. A resin with spectacular new properties is obtained by copolymerizing ethylene with vinyl acetate. It should be noted that in each case the copolymers have far different properties than the properties of the individual polymeric components, and properties not possible to obtain by a mere physical blending of the separate polymers. As more information is obtained and polymerization techniques become more refined eventually it may be possible to formulate a plastic coating by means of an electronic computer. Once the properties required of the coating are known the computer will not only determine the kind and number of building blocks needed and their arrangement in the polymer but also the stereo-configuration of the final single macromolecule.

Presented at the meeting of the Chicago Section of TAPPI, held in Chicago, Ill., March 7, 1961.

Ohio

R. W. Saudberg of the Chemical Development Department of the Research Division of the National Cash Register Co. was the guest speaker at the April 13 meeting of the Ohio Section.

The meeting was held at the Colony Club in Dayton, Ohio, and was preceded by a tour of the NCR Co., Engineering and Research Center at their plant in Dayton. Mr. Saudberg's talk was followed by an interesting question and answer session.

May Meeting

Hartwell Country Club at Cincinnati, Ohio, was the site of the Ohio Section's annual Ladies' Night event on May 11, 1961. Three hundred and sixty people attended the meeting which started with a social hour sponsored by paper industry affiliates.

After a dinner, the group was entertained by an all-male choral group, the Cincinnatians. Business was confined to a few brief remarks and the passing of the gavel by Charles Sweitzer to Burton Bailey, the new Ohio Section Chairman.

Harlan Vogel of the Cincinnati Gas and Electric Co. did a commendable job in handling arrangements for the evening. Activities were concluded with a continuation of the social hour and dancing.

NCR Capsular Development

R. W. Saudberg

The development of encapsulation and its application to paper is given in connection with no-carbon-required (NCR) papers. Possible new applications of this process are suggested.

THE title of my talk tonight is "NCR Capsular Development." It is difficult to adequately discuss such a complex subject in a short time, but I hope to give you a brief summary of at least some of the more significant points.

Some of the first questions that are usually asked are: "What is encapsulation?" Doesn't it have something to do with chemistry? How did The National Cash Register Co. ever get into this field?"

Briefly, encapsulation is the general name applied to our process for putting an impermeable film around a droplet of reactive, volatile, aromatic, or savory oil. The process involves the unique application of the laws of chemistry. Although this seems an unusual field for a manufacturer of business machines, the original project was initiated to solve a specific problem of record keeping with our equipment. In our work on this problem, we have developed a whole new technology that not only shows promise of solving problems of direct interest to us, but should be of considerable value to others as well.

In 1938, a meeting was held at NCR to discuss possible solutions to the problem of servicing and reinking the ribbons used in cash registers and accounting machines. Two unconventional suggestions were proposed at this meeting. In one suggestion it was proposed that the ink ribbon be eliminated and a reservoir of ink be placed behind porous type to produce the print. This idea was subsequently developed as "porous rubber" stamps. It was also proposed that the ribbon be eliminated and colorless, reactive materials be combined in a paper coating that would produce a visible mark when the paper was struck by the type. This idea was subsequently developed as NCR (no carbon required) paper. It is of some interest to note that although neither of these suggestions solved the original problem, both concepts were developed to produce commercial products that have achieved a considerable sales volume.

The initial research approach toward developing a color producing paper involved the preparation of a "self-contained" coating system which after being coated on paper would produce a record print under impact or friction. The first embodiment of this principle was made by coating a mixture of two solvent-based emulsions containing various colorless, water soluble, reactive ingredients. A typical formulation used dispersed droplets of glycerine containing a ferric salt or tannic acid in a gum damar matrix.

These systems were successful in that the two emulsions, containing the reactive ingredients, could be mixed without the premature formation of color. It was also possible to produce a colorless coated paper which gave an immediate, black record print after impact or friction. Unfortunately, the coatings were not very stable due to premature discoloration of the coating when exposed to variations in temperature and relative humidity. A completely new approach was initiated based upon the knowledge that there were a number of colorless organic compounds which, when adsorbed on a suitable reactive surface, would be polarized to a colored form. This color reaction is the basis for the "no carbon required" paper system.

It should be noted that the colorless organic compounds and the colorless mineral pigments that were selected early in the program are the materials which are currently being used in the manufacture of NCR paper.

R. W. SAUDBERG, Chemical Development Dept., National Cash Register Co., Dayton, Ohio.

Our first effort with the new system was to make a "self-contained" paper. A typical formulation consisted of an emulsion of an oil solution of the colorless dyestuff, or adsorbate, in an aqueous solution of a colloid such as gelatin, with the colorless mineral pigment, or adsorbent, dispersed in the external phase. In theory this mixture could be coated on paper to give a colorless sheet which, under impact or friction, would give a colored mark. In practice the adsorbate would penetrate the membrane wall and react with the adsorbent to give an overall premature discoloration and the colloid in the membrane wall would tend to "mask" the adsorbent and prevent reaction with the adsorbate under impact. All efforts to reduce the premature discoloration also reduced the impact sensitivity and vice versa.

"Self-contained papers" were also made by a two-coat process wherein an emulsion containing an oil solution of the adsorbate was coated on paper and dried. A top coating of the adsorbent and a poor adhesive, such as starch, was then applied over the emulsion. Although fairly satisfactory and stable, the process was very difficult to control and the project never reached the pilot plant stage. There was a tendency for a premature color reaction to occur at the interface between the emulsion coating and the adsorbent coating.

In 1948, our interest changed and the program on "self-contained papers" was de-emphasized. Work was initiated on the program which ultimately resulted in NCR paper. NCR paper is made by separating the reactive ingredients into different coatings, so that at least two papers are required to make one copy.

NCR paper is made in *three* different forms. The first sheet, which is called CB (coated back), was made by coating an emulsion containing an oil solution of the adsorbate on the back side of a sheet of bond paper forms. The last sheet, which is called CF (coated front), is made by coating a formulation containing the adsorbent on the front side of a sheet of bond paper forms.

To make a print, a sheet of CB paper is placed over a sheet of CF paper with both coatings in contact. Under impact, friction, or pressure, some of the oil is squeezed out of the CB coating and is transferred to the CF coating. The adsorbate is adsorbed by the adsorbent and polarized to a colored form to give a visible mark.

If more than one copy is required, the required number of CFB (coated front and back) sheets can be inserted.

The three different types of NCR paper are made in a number of different basis weights in both sheets and rolls. NCR paper is available in white, canary, green, blue, pink, and goldenrod colors. NCR paper is also made on special base papers for specific applications.

Our initial CF papers used special or modified kaolin clays as the reactive mineral pigment. These coatings were not commercially successful due to the limited number of adsorption sites available for reaction with our colorless dyestuffs. It was possible to greatly improve the intensity and permanence of the record print by the adoption of a special mineral pigment called Attapulgus clay. This clay has more reactive adsorption sites than kaolin.

Extremely complex problems had to be solved to develop formulations that would permit the use of Attapulgus clay in our coated papers. A program is still under way to improve CF coatings, but the adoption of Attapulgus clay was the first toward the development of a salable product.

At this time, the CB coatings were made by applying an aqueous emulsion to the paper. As the emulsion coating dried and the water evaporated, a dispersion of oil droplets was left within a gelatin matrix. Unfortunately, even under the best of conditions, the cell walls comprising the gelatin matrix contained pores large enough for the adsorbate and the solvent molecules to pass through. It was this microporosity, or "permeability," that was responsible for the premature discoloration of the "self-contained papers" developed in earlier efforts.

Even though the pores were submicroscopic in size, their existence created interconnections through the membrane wall between adjoining droplets. Significant amounts of even relatively nonvolatile solvents were lost by evaporation during storage. The loss of solvent, particularly at elevated temperatures, rapidly reduced the ability to make an acceptable print.

In spite of the limitations of this system, fairly satisfactory papers were made, and a number of mill trials were conducted in preparation for marketing a product. At this critical point, a significant breakthrough was made in the laboratory and commercial production was postponed until the new technique of encapsulation was perfected.

Micro-encapsulation is accomplished by a novel application of the phenomenon called "coacervation." "Coacervation" is an unusual type of phase separation, and must be distinguished from ordinary phase separation. B. K. Green, manager of NCR Chemical Research, defined coacervation for the "Encyclopedia of Chemistry" (published by the Reinhold Press in 1957) in the following manner.

"The term 'coacervation' was first used by H. R. Kruyt and H. G. Bungenberg de Jong in 1929 to describe the partial miscibility of optically isotropic liquids in which at least one of the liquids is macromolecular or colloidal in nature. The macromolecular or colloidal equilibrium liquids are known as 'coacervates.' "

The practical consequences of this definition is that one can mix a suitable pair of aqueous solutions and obtain an immiscible mixture although both phases contain water as the solvent. If the proper conditions are chosen, the macromolecular or colloidal material will be deposited and will form a shell around droplets of oil dispersed in the mixture. The significant point is that the shell can be deposited in such a way that the pores in the shell wall are smaller than the adsorbate or the solvent molecules. In other words, the shell wall is impermeable and the internal phase will not react or volatilize; it cannot be tasted or smelled until the capsule is broken. Many tons of NCR paper coated with such a capsular structure have held up for years without appreciable loss of solvent.

Many variations can be produced; the oil drop size can be varied over a very wide range (0.1 μ to 1 cm.) without affecting the process. A very wide range of materials can be encapsulated, but generally the more polar the oil, the more problems which are encountered. Materials as diverse as hydrocarbons, chlorinated hydrocarbons, volatile solvents, complex flavoring or odorous chemicals have been successfully encapsulated. The best results are obtained with materials that are essentially insoluble, unreactive with water, and stable to considerable changes in pH.

The technique of encapsulation is extremely versatile since there are a number of techniques which can be used to build desired properties into the structure. Although relatively minor changes in the process can cause major changes in the structure and properties of the capsules, predictable and reproducible results are obtained through careful control of the process variables.

One of the most useful properties of the microcapsule is its low viscosity when used as a water slurry. A true emulsion at comparable solids would be much more viscous and hence more difficult to use as a paper coating composition. The lower viscosity, of course, is due to the almost total absence of colloidal material in the aqueous phase.

The limited manufacture of NCR paper was begun in 1954 and tonnages have steadily increased in each succeeding year. The technical staffs of our paper suppliers contributed much to the solution of the coating problems.

Several paper suppliers attacked the problem of maintaining a uniform quality of production. Although each supplier has adapted our basic formulations to fit the requirements of their operation, it has been possible to maintain NCR paper as a uniform, institutional product.

In initiating the commercial production of NCR paper, the manufacture of the encapsulated material was centered in our Dayton plant. Several factors dictated the manufacturing location here: (1) the protection of patent coverage and know-how, (2) greater efficiency and control over the production, (3) availability of equipment for scale-up and production of related products, and (4) resident personnel capability.

The encapsulated material or "NCR emulsion" is manufactured to rigid specifications and extensively tested before approval and release for shipment. The emulsion is sold to the coating mills at a standard price. After combining the "NCR emulsion" with other necessary ingredients, the mills coat it on paper which must meet NCR purchasing specifications. The paper is sold to NCR, but in most cases is shipped to our customers directly from the mill. Representative samples of each roll of paper are sent to Dayton for further test.

In this way a direct control and responsibility for the quality of the product is maintained by our company. All specifications and limits, however, have been established only with the assistance and approval of the paper suppliers.

Over the past five years, much progress has been made in improving the quality and uniformity of NCR paper production. This improvement in quality has been reflected in the steady increase in the customer demand.

NCR paper has achieved a remarkable sales volume and even greater growth is anticipated in the next few years. Present research programs are designed to improve the efficiency of the capsular structure in order to facilitate broader application in the field.

In perfecting the processes of encapsulation for NCR paper, an entirely new technology has been developed which provides the capability for encapsulating an increasingly wide range of materials. One of the results of this new technology was renewed emphasis in the development of "self-contained paper."

It is now possible to mix the reactive materials in the wet state and to dry them without premature discoloration. Not only are "self-contained" coatings possible, but even "self-contained" capsules have been prepared wherein each individual capsule is able to produce color when ruptured.

Sizable quantities of "self-contained paper" have been made under production conditions and field testing and evaluation is under way. "Self-contained paper" is expected to achieve full commercial status this year. This product will have tremendous impact in a number of specialized applications including high speed printers and recorders.

A completely new application of the self-contained development is "self-contained paper CB." This paper consists of "self-contained paper" with regular NCR "CB" emulsion on the back. Copies can be made by simply using regular NCR paper as a part of the manifold.

Although one of the major advantages of NCR paper is that it is a "clean" system that will produce a mark only on specially treated papers, there are times when it is desirable to make a visible print on an untreated sheet or a special kind of paper.

A paper coated with an encapsulated black, oil-base ink called "black colored marking paper" is a recent development. The advantage of this product is that a sharp, no smear ink print can be produced on the copy as well as the original.

Amother area of application is that of special adhesive papers involving activation by heat or pressure.

There is a host of other applications, such as papers to "dry wash" the hands and face, remove spots from fabrics, apply antiseptics or deodorants. The possibilities for application to such product areas is almost endless.

It is also possible to develop products that would not be coated on paper, such as free flowing, dry powder, or solid blocks of material. By the use of suitable drying techniques, many materials can be encapsulated in such forms without destroying the impermeable shell around each individual droplet of active ingredient.

The applications for such materials are limitless. Suitable perfumes or flavoring materials can be encapsulated; pharmaceutical products encapsulated for masking the odor or taste; controlled-release pharmaceuticals for prolonged medication; toxic fumigants or spray chemicals for safer handling along with controlled release for greater effectiveness over a long period of time.

The NCR encapsulation program is an excellent example of the results that can be achieved in an industrial laboratory through the use of well planned and coordinated team research. Our goals have changed over the years as our knowledge and technical capability increased. The program as a whole has been characterized by a clear-cut statement of the results to be obtained. Although the membership of the teams changed as one or another scientist was added or subtracted to provide specific technical support, the final success is due to the cooperation and contribution of a greater number of people.

Presented at the meeting of the Ohio Section of TAPPI, held in Dayton, Ohio, April 13, 1961.

New England (Bay District)

A New Anionic Polyacrylamide Flocculant

Norman T. Woodberry

The general chemistry and laboratory results obtained with a new retention aid, Accurac 24, are given. The product is the result of vinyl copolymerization of acrylamide and acrylic acid. Suggestions are given as to its use.

THE use of additives as filler retention aids on the paper machine is widespread. Numerous articles have appeared wherein attempts have been made to explain the mechanism by which these additives act in paper mill systems. For example, Cushing and Schuman (*1*) have discussed the role of polysaccharides in interfiber bonding. Brill (*2*) has written about the use of chlorinated corn starch as a titanium dioxide retention aid. Reynolds and Ryan (*3*) as well as Date and Shute (*4*) have reported on the use of nonionic polyacrylamide-type flocculants in papermaking furnishes.

Cyanamid has been interested in synthetic additives for many years and has maintained an extensive research program in this area. Perhaps you are familiar with Cyanamid's anionic dry strength resin, Accostrength Resin 2386. In the mill trail evaluation of this product a number of years ago, some mills reported an increase in filler retention; other mills found improvements in drainage rate which led to increased production rate.

Further laboratory investigations have resulted in the development of Cyanamid's new flocculating agent marketed as Accurac 24. This paper will discuss some of the chemistry of this product as well as some of the papermaking variables which must be controlled for the resin's successful use in mill applications.

ACRYLIC RESINS IN PAPER

General Chemistry

Accurac 24 retention aid is made by the vinyl copolymerization of two monomers, namely, acrylamide and acrylic acid. These are made from acrylonitrile which is one of the basic chemicals of the chemical industry today and has the distinction of being more or less directly made from coal, air, and water. Natural gas methane is converted by air and ammonia to hydrocyanic acid and acetylene which add to one

NORMAN T. WOODBERRY, Research Chemist, Stamford Research Laboratory, American Cyanamid Co., Stamford, Conn.

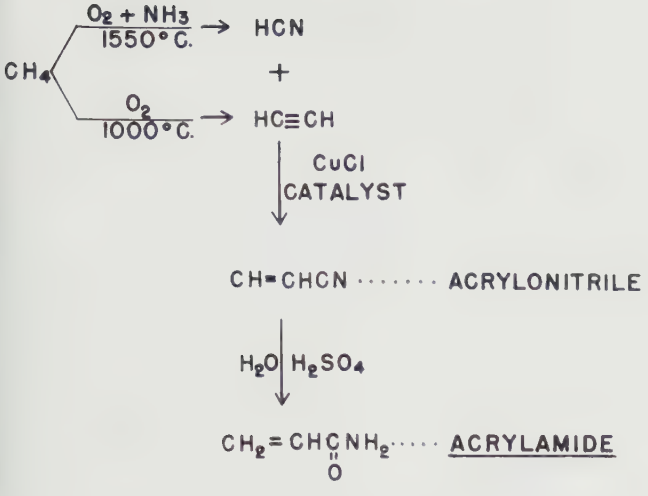


Fig. 1

another upon being catalyzed to give acrylonitrile. This may be acid hydrolyzed to acrylamide and acrylic acid (this is outlined in Fig. 1).

Copolymers of these various vinyl monomers are readily made by batch and continuous processes in an aqueous system. The dry product may be obtained in several ways. Drum drying and solvent precipitation are two commonly used methods. The composition, molecular size (weight) and architectural arrangement of the polymer chains may be controlled by the polymerization conditions. That is, the concentration of the monomers and polymerization catalysts (oxidizing as well as redox types) and reaction temperature control the nature of the final resin. Low catalyst usage and low reaction temperature generally lead to relatively high

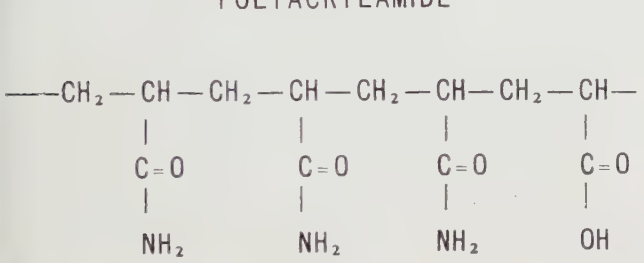


Fig. 2

molecular weight, straight-chained polymers. In Fig. 2, a schematic representation of Accurac 24 retention aid is shown.

Most of these resin variations have been evaluated in paper applications. From these investigations, it has been possible to correlate polymer structure with a particular paper application. This relationship is shown in Fig. 3. Low molecular weight acrylamide polymers containing a relatively high number of carboxyl groups are dispersants whereas high molecular weight polymers with low carboxyl content serve as flocculants. An intermediate molecular

Table I. Laboratory Test Procedures

I	Pigment retention	
	A.)	Stock treatment
	B.)	Paper tests
		1.) Titanium dioxide, clay—ashing
		2.) Calcium carbonate—titration
		3.) Colored pigments—reflectance
	C.)	Opacity
II	Drainage	
	A.)	Canadian standard preeness tester
	B.)	Visual observation of fiber floc.
III	Usual paper tests	
		Porosity, tensile, burst, fold, and tear tests

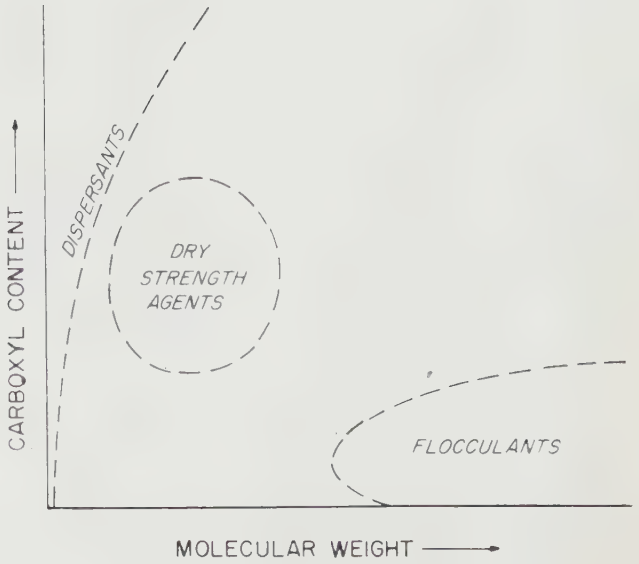


Fig. 3. Applications of acrylamide-based polymers

weight and carboxyl content represents a resin showing good dry strength efficiency.

As has been mentioned, this new retention aid is a high molecular weight resin made anionic by the presence of a small number of carboxyl groups. It is sold as a dry, white, odorless, free-flowing stable powder.

Because it is a high molecular weight material, water takes time to diffuse into each resin particle. Hence, in order to dissolve the resin in a reasonable length of time, care should be taken in preparing a solution. The resin is slowly added to water under vigorous stirring. In this way each particle of resin is kept separate from the other. As soon as the resin addition is completed, the rate of stirring is greatly reduced in

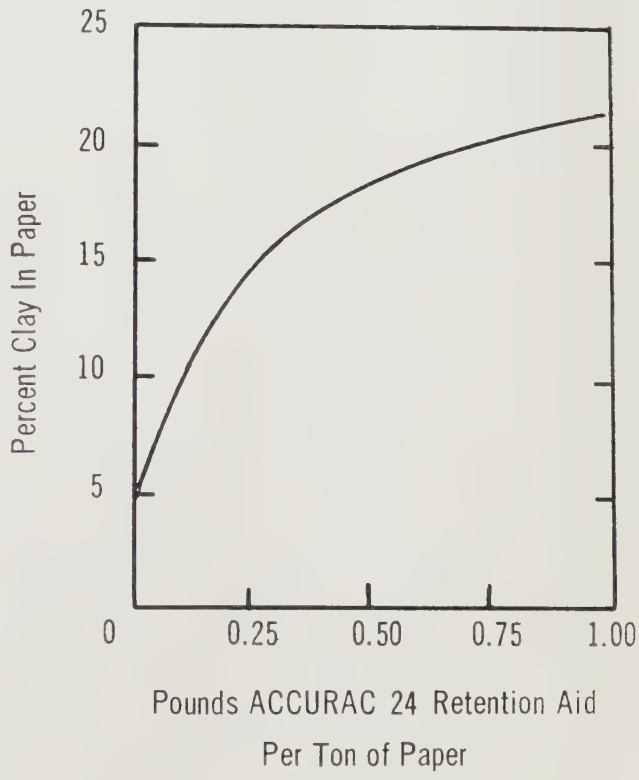


Fig. 4. The effect of Accurac 24 concentration on clay retention

order to avoid molecular degradation of the polymer by the shearing action of the stirrer.

Commercially, the process for dissolving or dispersing the resin is easily carried out by using a dry-solids feed eductor. The formation of large resin agglomerates is thus avoided.

Because of its high molecular weight, solutions whose resin concentration exceeds 2% by weight will be very viscous and too difficult to pump. In the mill, the resin solution is prepared at 1% concentration using luke warm water. After the resin is dissolved (1 to 2 hr.), it is diluted 20 fold. At this lower concentration of 0.05% proper distribution of the resin through the stock is assured. Properly prepared solutions should be clear and possess a pH of about 4.

Laboratory Testing Procedures

The laboratory testing procedure is summarized in Table I. No detailed explanation need be given except to discuss briefly the stock treatment procedure. In both experiments for pigment retention as well as drainage, the dilute stock is treated with rosin size, pigment if required, and alum. The stock is then adjusted to the desired pH prior to the addition of flocculating resin. Then required aliquots (i.e., 3 g. dry fiber-500 ml.) for single Nash handsheets or a Canadian Standard freeness test are measured out in graduated cylinders. This stock which is used for a single sheet is treated just prior to addition to the sheet mold with the appropriate amount of dilute flocculating resin, which is mixed with the treated stock by inverting the graduated cylinder five times. Following this procedure in conjunction with standard sheet making or freeness testing procedures, reproducible laboratory results have been obtained.

Laboratory Results

Since the retention aid is an anionic resin, its successful use with negatively charged cellulosic fibers is dependent upon the "binding" action of papermaker's alum. Considerable time has been spent in our laboratories in experiments designed to understand the mechanism by which this adsorption of an anionic material takes place. There are several conclusions we have reached about this mechanism.

1. The quantity of alum used must be sufficient to neutralize the negative charges of the cellulose as well as the anionic resin it is binding to the cellulose-pigment system,

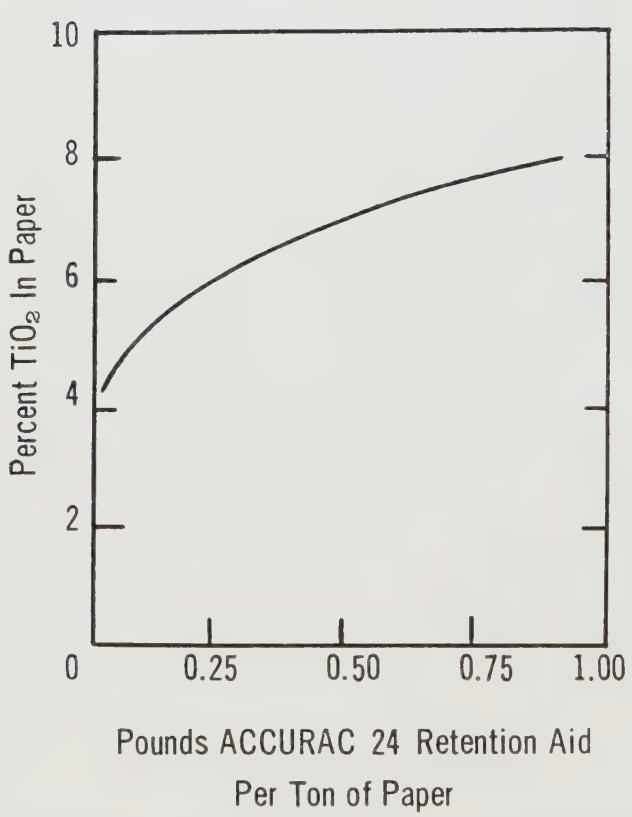


Fig. 5. The effect of Accurac 24 concentration on TiO_2 retention

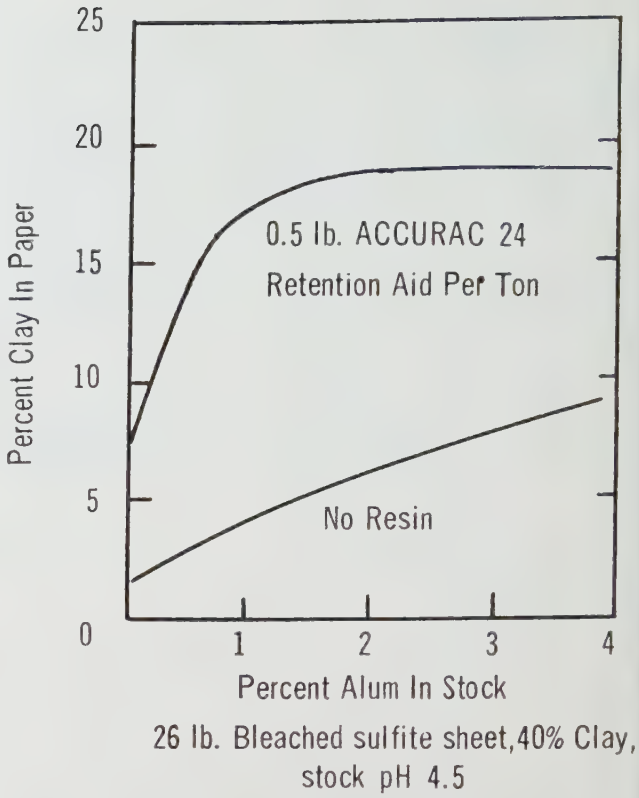


Fig. 6. The effect of alum on Accurac 24 efficiency in clay retention

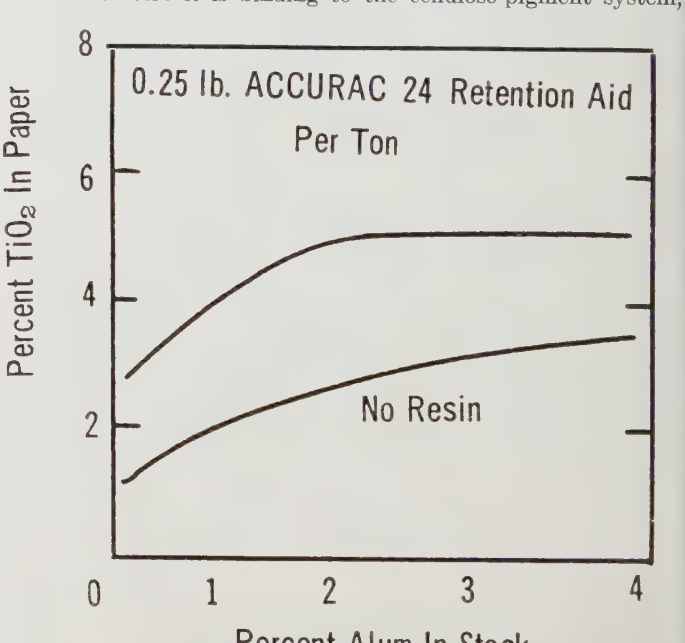


Fig. 7. Effect of alum on Accurac 24 efficiency in TiO_2 retention

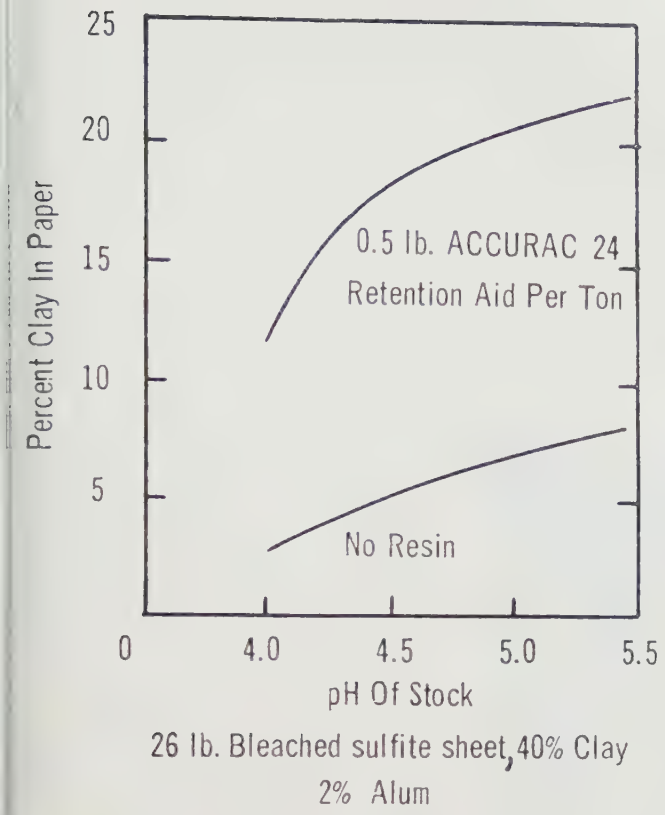


Fig. 8. The effect of stock pH on Accurac 24 efficiency in clay retention

for optimum improvement in pigment retention or in drainage rate.

2. The degree of neutralization of the aluminum ion determines the size of the alumina floc as well as its charge, which in turn determine the extent of floc's adsorption to the cellulose and the acid groups of the resin. Thus it is important to control the stock pH.

3. The order of addition is important. The aluminum floc or complex must be in the pulp system prior to the addition of the flocculating resin.

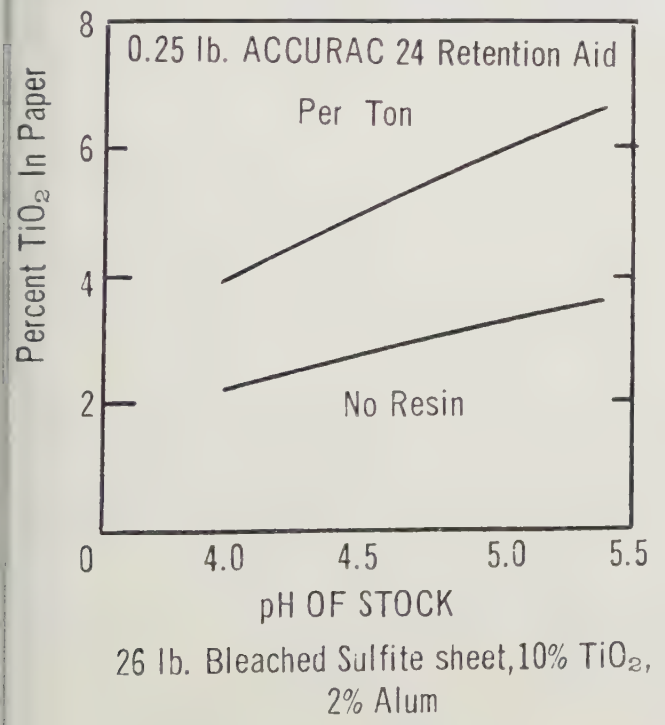


Fig. 9. Effect of stock pH on Accurac 24 efficiency in TiO_2 retention

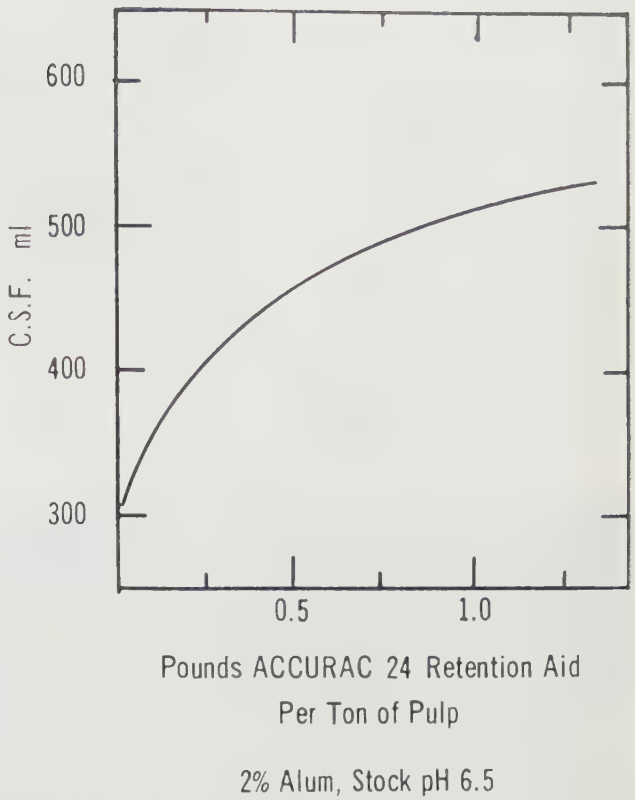


Fig. 10. The effect of Accurac 24 concentration on drainage rate

The effectiveness or efficiency of Accurac 24 retention aid in increasing the retention of clay and titanium dioxide fillers on a bleached sulfite are shown in Figs. 4 and 5. In these experiments 2% alum and a stock pH 5 adjustment were used. It is readily seen that small quantities of resin will effect a considerable improvement in the filler content of the sheet. In Fig. 6, the alum requirements with clay are shown. Even the increased use of alum causes, as expected, some increase in clay retention. Some improvement is also obtained by the use of the retention aid itself. The optimum

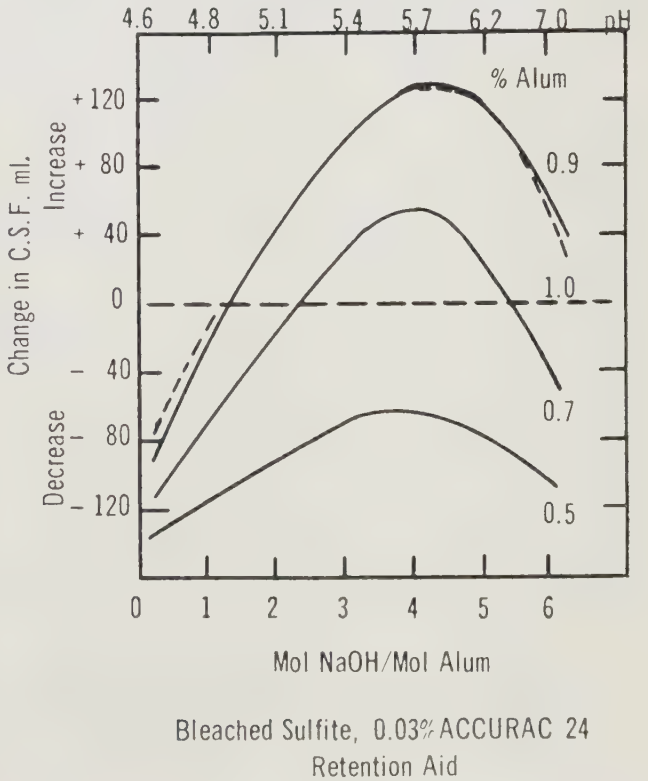


Fig. 11. The effect of alum and stock pH on Accurac 24 efficiency as drainage improver

clay retention is obtained, however, when the alum usage is raised to at least 1%. Similar results are obtained for titanium dioxide as shown in Fig. 7.

The pH effect is demonstrated in Figs. 8 and 9. In the range pH from 4 to 4.5 where the complex monohydroxy aluminum ion is forming, the greatest increase in Accurac 24 retention aid efficiency is obtained. Similar results, yet not as dramatic as the clay, were obtained for titanium dioxide. This difference may be due to the inherent differences in the silicon dioxide clay structure and the titanium dioxide structure.

Let's briefly look at the flocculation of fibers themselves. This effect is readily studied in the laboratory as mentioned earlier by measuring the freeness of pulps treated under various conditions. In Fig. 10, one sees again that relatively minute quantities of the flocculating resin will free up the stock.

The dependence of drainage rate on the alum usage and pH conditions is shown in Fig. 11. Under some conditions the drainage rate is decreased by the resin, and this may be a bulk solution-viscosity effect. However, when the alum is 50 to 60% neutralized, the hydrated aluminum complex is readily absorbed by the fiber and the flocculating agent and thus the largest increases in drainage rate as measured by the freeness test.

In all of these experiments, it should be noted that treated pulp was agitated only to the degree necessary for uniform distribution of the resin, and that the resin was added last. This is important, for in all applications of Accurac 24 retention aid, the floc, whether it be pigment and fibers, fiber fines, or some colloidal by-product effluent, is broken down by excessive mechanical action.

Some pulps have been rosin sized in addition to other treatments; this material does not affect the action of the flocculating agent. However, some starches interfere with the use of resin. Cationic starches do not appear to interfere.

COMMERCIAL APPLICATIONS

Briefly, the results of a number of commercial applications are summarized here:

In one application a 60-lb. offset paper, 4 oz. per ton addition of Accurac 24 retention aid at the headbox greatly increased titanium dioxide retention with the opacity increasing from 92 to 94%.

In a 60-lb. book paper 7.5 oz. per ton of resin increased the titanium dioxide clay retention 50% and the opacity went from 93 to 95.5.

In another mill calcium carbonate filler was increased 50% even with the pH 9 alkaline conditions that naturally occur with this alkaline filler.

Resin used in 3 p.p.m. at flotation-type saveall greatly increased its efficiency giving a satisfactory mill stream effluent.

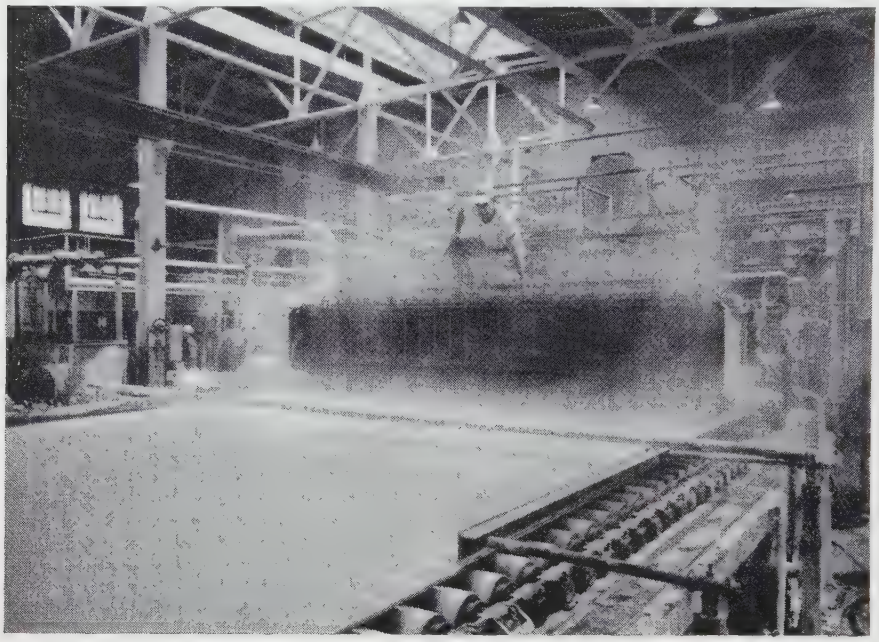
Economic conditions in some measure dictate the production rate of any paper machine. The efficiency of Accurac 24 retention aid has improved the drainage rate and rate of drying (steam consumption) in a number of mills when the resin usage was as low as 4 oz. per ton.

LITERATURE CITED

1. Cushing and Schuman, *Tappi* 42, No. 12: 1006 (1959).
2. Brill, *Tappi* 38, No. 9: 523 (1955).
3. Reynolds and Ryan, *Tappi* 40, No. 11: 918 (1957).
4. Date and Shute, *Tappi* 42, No. 10: 824 (1959).

Presented at the meeting of the Bay District of the New England Section of TAPPI, held in Framingham, Mass., Jan. 9, 1961.

The author wishes to acknowledge the contributions that W. F. Linke and W. F. Reynolds, Jr., have made to this investigation.



CUT THE COST OF PAPER-MAKING WATER WITH W&T TREATMENT EQUIPMENT

Wallace & Tiernan Water Treatment Equipment makes water go further, stretches your paper-making dollars.

Job-proportioned V-notch Chlorinators meter 0.5 to 8000 pounds of chlorine per day accurately, reliably, safely. They destroy slime-forming organisms in your fresh water. You save through reduced breaks, improved paper quality.

With W&T Chlorinators you run white water through again and again; use less fuel to heat it, less chemical for reconditioning.

W&T Chlorinators keep condensers slime-free. You increase cooling efficiency, reduce down-time for cleaning.

W&T Metering Pumps and W&T Volumetric and Gravimetric Feeders add your stock chemicals exactly. You get correct dosages of alum, alkalis, size. You save on chemicals, boost paper quality.

For information on Wallace & Tiernan Treatment Equipment, write Dept. S-147.91.

WALLACE & TIERNAN INC.
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

Review of the Literature on Pulp and Paper Mill Wastes—1960*

STREAM POLLUTION

THE 19 papers delivered at the Pulp, Paper, and Paperboard Industrial Waste Conference (*1*) have been reproduced. They cover many phases of pulp and paper industry waste treatment including solids removal and disposal, B.O.D. reduction, and the recovery of strong semichemical and sulfite liquors. Basic papers on the waste assimilative capacity of streams and aquatic biology are also included. A novel automatic ratio-controller system for effluent dilution installed by Bowaters Caroline Corp. is described by Bowers (*2*). The system protects the Catawba River which is highly variable in flow due to upstream hydroelectric uses.

A cooperative plant to biologically treat wastes from the West Virginia Pulp and Paper Co. mill at Luke, Md., and three adjoining communities, has recently been placed in operation (*3*). The activated sludge plant will treat 21 m.g.d., employs turbine aerators and is designed for a 6.5 hr. aeration period with a 40% return sludge flow. A thickener and vacuum filter are being used to dewater waste sludge.

Sulfite

The major emphasis in the sulfite spent liquor field remains on chemical recovery and by-product processes. A thorough review (*4*) of the various recovery systems now in use or under development, including magnesia base, Sivola sodium-base, and Stora Kopparberg, indicates that rapid progress is being made in finding suitable and economically feasible processes.

There were reports of expansion of chemical by-product plants from several sulfite mills. New capacity was added at Lignosol Chemicals (*5*) for products used in the manufacture of gypsum wallboard, dyestuffs, ceramics, refractory brick, and linoleum cement. At Puget Sound Pulp & Timber Co., the residues from the plant producing ethyl alcohol from spent liquor are being processed for various products used in adhesives, cement dispersion, oil well drillings, etc. (*6*).

The economics for furfural production from hardwood sulfite spent liquor are such to make the process relatively unattractive unless some of the costs are charged to pollution abatement (*7*). Holderby and Moggio (*8*) discuss the factors involved in growing yeast in spent sulfite liquor. Operating results for the torula yeast plant at the Rhinelander Div. of St. Regis Paper Co. show a 60% reduction in the B.O.D. of the liquor with a 90% removal of the sugar fraction. The fermentor removal is 3.26 lb. B.O.D. per cu.ft. per day, while the dry yeast is 0.63 lb. per lb. B.O.D. removed. A process for the production of alcohol from spent liquor is claimed by Opderbeck (*9*) which involves pH adjustment, addition of fungi enzyme to bring about hydrolysis of the polysaccharides, yeast fermentation, and distillation of the alcohol. Cirillo (*10*) reports a fermentation process for producing edible mushroom mycelium using a liquid culture containing spent liquor.

Several reports regarding the effect of biologically treated spent liquor on slime growth and aquatic organisms were issued during the year. Cormack (*11*) found a 75 to 93% reduction in the weight of *Sphaerotilus natans* growth when treated liquor was used over untreated liquor in laboratory test channels. The treatment process to which the liquor was subjected was a modified activated sludge process at high temperatures —56°C. The process was capable of removing 68% of the B.O.D. in 12 hr. at a loading of 2.4 lb. B.O.D. per cu. ft. per day. Marczek (*12*) made microscopic investigations of the fauna and flora in spent liquor under aeration. He concludes that biologically treated sulfite liquor can be safely discharged to rivers or lakes.

Where high dilution is available most of the year, storage of spent liquor during low flow periods and subsequent discharge at high flow has proved a satisfactory means of disposal. Buehler (*13*) discusses the experience of Nekoosa Edwards Paper Co. with a liquor lagoon which resulted in a 43% reduction in downstream B.O.D. levels. By use of a temperature controlled diversion system for spent liquor from the blowpits, it has been possible for the West Linn, Ore., mill of Crown Zellerbach Corp. to reduce the flow of liquor from 8.0 gal to 4.65 gal. per lb. of B.O.D. pumped, thus conserving lagoon volume (*14*).

Kraft and Semichemical

The steps taken by the Maryvale kraft mill of Australian Paper Mfrs., Ltd. to meet the stringent effluent disposal requirements of the Victoria Rivers and Water Supply Commission are discussed by Stops (*15*). Laws (*16*) compares the use of diffusers and mechanical turbine aerators in the activated sludge plant of West Virginia Pulp & Paper Co. at Luke, Md. The diffusion aerators originally used were found to be unsatisfactory due to scale build-up in the diffuser orifices. This was attributed to the high calcium content of the waste. A 40% power saving has resulted from the substitution of turbine aerators for diffusers. The turbine aerators dissolve 1 lb. of oxygen per 0.29 kw.-hr. and no maintenance has been required in 7 months operation.

The color of kraft effluents is not diminished by biological treatment. A new process (*17*) which integrates color removal with the kraft recovery process by using the lignin-containing lime sludge directly to recausticize green liquor has been shown to be feasible. Color removals greater than 90% and B.O.D. removals of about 45% have been obtained in the laboratory. A method for recovering lignin from alkaline bleach effluents is claimed by Doughty (*18*). The effluents are treated

* This review on stream pollution appeared as part of the annual review of the literature Prepared by Federation Research Committee and published as a part of the *Journal Water Pollution Federation* for June, 1961.

with alum to precipitate the chlorinated lignin and the precipitate recovered.

Othmer (*19*) claims a process for the recovery of acetic acid and other lower fatty acids from spent pulping liquors, including black liquor from the kraft and neutral sulfite semichemical processes. A method of concentrating spent pulping liquors so that they have a sufficiently high solids content to maintain combustion is claimed by Flynt (*20*). The method involves bringing the liquors from the pulp washers into direct contact with the hot flue gases obtained from the incineration of the concentrated liquor. It is claimed that the method is economical and suitable for use by smaller pulp mills.

Paper Mill

The search for the elusive completely "closed" white water system for paper mills continues. Gummels (*21*) reports on the Pista process and claims the process completely removes fibers and colloids from the white water, thus allowing full recirculation. The process consists of coagulation of the white water with ferric sulfate and lime and sedimentation. It would appear that the dissolved solids build-up would eventually become a problem necessitating the introduction of fresh water at some point. The importance of good retention of stock on paper machine wires on subsequent saveall operation is discussed by Tifft (*22*). Proper use of retention aids may be a major factor in the control of white water losses. The Russel separator is being used for recirculation of wash water and recovery of pulp fibers in the manufacture of molded-pulp articles at the Hartmann Fibre Co., Great Yarmouth (*23*). This screening apparatus works on the principle of gyratory vibration in a horizontal plane and can treat up to 250 g.p.m.

Refinements are continuously being made on recovery units in use in paper mills. Klebanoff (*24*) describes control systems for improving flotation save-all performance. These controls are concerned with maintaining constant pressure and flow and an automatic weir to insure uniform operation of sludge scraper blades. Quirk (*25*) found that 70% of the total B.O.D. of boardmill effluents was in a dissolved state. Sedimentation periods of 60 to 90 min. result in removals of 70 and 11%, respectively, of the suspended solids and B.O.D. of these effluents. Chemical treatment employing iron and aluminum salts in dosages of about 100 p.p.m. and coagulation aids were required to obtain a maximum B.O.D. removal of 30%.

Klinger (*26*) reviews methods for handling the discharge of boardmill effluents for their reuse. Examples of both primary and secondary treatment plants are given. The biological treatment unit which is of the Aero-Accelator type is designed to treat 14,600 lb. of B.O.D. daily and test runs have shown that removals of 89 to 96% can be achieved. Sludge thickening and digester facilities have been provided for disposal of excess activated sludge.

The problem of the dewatering and disposal of solids resulting from the clarification of paper and pulp mill effluents remains one of the more difficult problems facing the industry. Nadelman (*27*) reports on the chemical and physical characteristics of deinking sludge as related to the possible reuse of these solids in the deinking process or in other products. The utilization of modified sludge as filler for paper and rubber goods and as building material appears possible.

It would appear that disposal rather than reuse of paper mill sludges will be the treatment of these materials in the foreseeable future. A review of the nature of the problem, research, and development activities, and current methods of sludge handling, are reviewed in a recent National Council Bulletin (*28*). Data are given on sludge thickening, centrifuging, and filtration, and while there appears to be no universally applicable solution to the disposal problem, maximum concentration of solids prior to dewatering is desirable in all cases. Field studies on the use of a conveyor type centrifuge in dewatering board mill waste solids showed that cake solids greater than 28% could be obtained at moderate flow rates (*29*). Preliminary estimates for dewatering low solids content sludge indicate a cost of $6.25 per ton of dry solids for the process, making it competitive with vacuum filtration. Tests (*30*) on a series of paper mill sludges have indicated that these sludges could be handled in conventional sludge-burning equipment. The volume of ash produced from burning has ranged from 48 to 81% less than the volume of the initial sludge.

Various types of biological oxidation processes are being used to reduce the B.O.D. of pulp and paper mill wastes. A general review of oxidation lagoons is made by Blosser (*31*). More oxygen transfer by surface reaeration per unit of volume can be obtained by storing at shallow depths, preferably less than 3 ft. The addition of nitrogen and phosphorous accelerates the rate of B.O.D. removal as does the introduction of free oxygen by natural or mechanical means. Eckenfelder (*32*) reports that B.O.D. removals up to 80% have been obtained on paper mill waste in aerated lagoons and concludes that this process affords an economical method of waste treatment where land is available.

The use of plastic trickling filter media has been studied by Egan (*33*). Loadings up to 750 lb. B.O.D. per 1000 cu.ft. per day of hot well condensate plus miscellaneous waste waters from an integrated kraft mill were applied without impairing efficiency. Removals of approximately 50% were obtained. At temperatures in the range of 45 to 60°C., a biota was developed which was able to effectively reduce the B.O.D. of the waste. Waldmeyer (*34*) describes a small diffused air activated sludge plant at the Tovil and Bridge mills of the Reed Paper Group, Maidstone, England. The effluent has a very low B.O.D.—below 10 p.p.m.—and an average suspended solids concentration below 30 p.p.m.

Finally, a process is under development at the University of California (*35*) which may result in the elimination of waste effluents from chemical pulping. In the process wood chips, sawdust, and other logging residues are first treated with nitric acid and ammonia. The waste waters are neutralized by mixing and the solution distilled to remove excess ammonia. The resulting neutral solution contains ammonium salts of organic acids and some residual nitric acid and can be used with or without concentration as a fertilizer.

Taga (*36*) reports on dilution studies for the semichemical mill effluent of the Honshu Paper Mfg. Co. Both fresh and sea water were used and 48-hr. tolerance limits were established. A study of the populations of sulfur-reducing bacteria in a certain section of the Ottawa River below a sulfite mill, was reported by Desrochers (*37*). The numbers of bacteria were determined over a 10-mile section and were found to be high-

est at points of maximum B.O.D. and low dissolved oxygen. Chambon (*38*) found that products with a phenolic reaction in paper mill waste were largely lignin for which the toxicity is practically nil. Wilson (*39*) reports on methods devised for sampling and determining slime growths in rivers. The methods developed include a bottom trawl, tile-box sampler, and a modified Reighard tow net.

Zieminski (*40*) was able to increase the efficiency of oxygen absorption in bubble aeration by 50 to 100% by adding 3 to 6 p.p.m. of some alcohols and carboxylic acids. The improvement in the rate of oxygen transfer was found to increase progressively with the length of the carbon chain; 4-methyl-2-pentanol and isoamyl acetate proved to be the most effective. Wiley (*41*) reviews various methods of reaerating streams. Methods and results for different types of aeration show that oxygen may be introduced at efficiencies on the order of 25 to 45% absorption of the oxygen from air introduced by mechanical methods and at costs as low as $3 to $20 per ton of oxygen actually absorbed. Forced air diffusion, spray aeration, and other methods of mechanical aeration have been studied and may eventually be used for stream reaeration.

Dillingham (*42*) gives results of experiments on a short-term, pure-culture manometric technique for determination of B.O.D. as a means for the prediction of 5-day dilution-method B.O.D. It was found that the correlation curves allowed the prediction of 5-day B.O.D. from 18-hr. manometric B.O.D. with about the same (or lower) 95% confidence limits as when using the 5-day B.O.D. alone. Basic studies on the microbial decomposition of lignin were pursued by Tabak (*43*). In these studies lignan (x-conidendrin) which is of a less complex methoxylated aromatic structure was used because of its structural relationship to lignin. Bacteria capable of decomposing x-conidendrin were isolated from several geographical locations including manure, soil, and water from below paper mill outfalls. Pseudomonad strains were most numerous and most active while mixed cultures were more effective than pure.

AIR POLLUTION

The increased attention the pulp and paper industry is giving the control of atmospheric emissions from its operations is reflected in the growing amount of literature published each year on the subject.

A method for analyzing kraft mill waste gases involving adsorption sampling on silica gel, heat-vacuum desorption, and gas-liquid chromatographic analysis is described by Adams (*44*). Water vapor is eliminated from the gas stream by condensation at 0°C. and a desiccant such as anhydrous calcium sulfate. Details of the method which has been successfully tested at a number of West Coast kraft mills are given in another publication (*45*). A somewhat more simplified technique which yields more qualitative data on the amounts of various sulfur compounds in kraft mill recovery stack gas has been tested at the University of Florida (*46*). The gaseous component of the stack gas is analyzed for hydrogen sulfide, sulfur dioxide, and total sulfur as sulfur dioxide, respectively. By this procedure, other reduced sulfur compounds are determined by difference.

A number of articles on simplified analytical methods for compounds associated with chemical pulping appeared during the year. While these references were not concerned with pulping emissions, they are mentioned here as a matter of general interest. Welch (*47*) reports that the sodium tetrachloromercurate method, TCM, (West) was found to be accurate, highly sensitive, flexible, and a practical method for the measurement of atmospheric concentrations of sulfur dioxide. A dynamic calibration of this method with the Thomas Autometer showed the two yielded identical results. The lead peroxide candle method which is used for gross estimations of sulfur dioxide is also described. A field method for determination of sulfur dioxide is described by Hands (*48*) which employs filter paper impregnated with an ammoniacal solution of zinc nitroprusside.

The brick red stain which develops on the filter paper in the presence of sulfur dioxide is compared with a standard stain chart or with a disk of standard tints to determine the concentration.

Gruber and his associates (*49*, *50*) discuss techniques for making odor investigations which may have applicability in the sulfate pulping field. In the first of the articles (*49*), techniques for determining odor based on inanimate instrumentation are criticized as being specific for one odor, not sensitive enough and incapable of handling mixed and unknown odors. Various devices which use a human observer are then recommended. Of these, the syringe technique and the Nader dilution apparatus are suited for source measurements of odor, while the flask dilution technique and the Scentometer appear best for ambient odors. The Scentometer (*50*), which is used by the Cincinnati Bureau of Air Pollution Control for ambient odor investigations, is of the vapor dilution type. The various dilutions are supplied by combinations of critical size orifices. Purified air for the purpose of dilution is supplied by activated carbon beds. The mixture is delivered to the olfactory tract for appraisal through two nose pieces, air being drawn through the instrument by action of the observer's lungs.

The great majority of sulfate pulp mills use electrostatic precipitators as the basic recovery devices on black liquor furnaces. The importance of routine maintenance in providing for uninterrupted precipitator performance is emphasized by Rabkin (*51*). Suggestions are given regarding the maintenance of the tile shell, alignment of discharge electrodes, rapping equipment, collecting equipment, and electrical equipment are given. Lagarias (*52*) reviews the functions of the electrodes in electrostatic precipitators. Laboratory and field data verify the use of barbed discharge electrodes to improve precipitator efficiency. Examples are given of improvement in efficiencies obtained at existing locations by replacing conventional electrodes with barbed ones.

A recent development in kraft mill recovery processes has been the use of wet scrubbers following electrostatic precipitators to minimize agglomeration of the precipitator exit gas and to provide partial treatment during periods of precipitator shutdown. Murray (*53*) evaluated various types of scrubbers for this purpose, including Venturi, packed, and plate-type units. The full-scale installation was of the spray Venturi type with 473 individual spray nozzles and Venturi throats in four separate staggered banks. Two 1800 g.p.m. pumps were used to maintain 40 p.s.i. nozzle pressures. First (*54*) describes the operation of several full-scale fog type

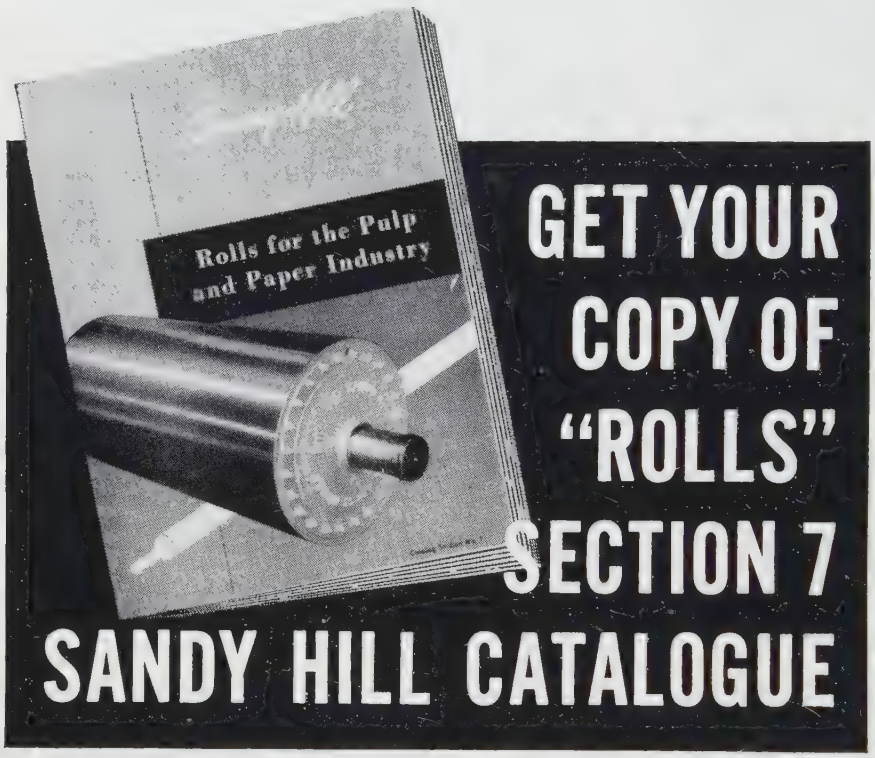
scrubbers. Efficiencies of 86 to 91% are reported for these units with outlet loadings in the 0.02 to 0.04 per cu. ft. range. Semrau (*55*) attempts to correlate from a number of literature references, scrubber efficiency with power dissipated per unit of gas flow. The data indicate that efficiency has little relation to scrubber design and geometry but is dependent on the properties of the particular aerosol and the contacting power. The latter is essentially equal to the pressure drop across the unit. Also the contacting power derived from hydraulic spray nozzles is equivalent to that derived from gas pressure drop. References to actual lime kiln and recovery furnace tests are given.

Increasing attention is being given to the limited but often troublesome discharge from the dissolving tank stack of kraft mills. Fenwick (*56*) reports that a dissolving tank stack economizer installation resulted in heat and chemical savings during the first year which was calculated to be 50% of the installation cost before taxes. Mesh-type separators have also been used in these stacks as well as on black liquor evaporators. Jurgensen (*57*) reports on the latter use of these units.

O'Brien (*58*) describes the extensive air pollution abatement program undertaken by S. D. Warren Co.'s Cumberland Mills, Me., mill prior to the conversion from soda to kraft pulping. The main features of the system are a Trobeck black liquor oxidation system with a Howard Smith centrigugal foam breaker, a tower in which the noncondensable digester relief and blow gases are chlorinated to destroy odor, and a conveyor system for salt cake unloading and transfer.

The decreased emission of reduced sulfur compounds from the recovery furnace stack, which results from oxidation of black liquor, has been fairly well established. This factor, together with the chemical savings possible, has made this process increasingly attractive to kraft mills. The installation of a Collins black liquor oxidation system at Western Kraft Corp. (*59*) is reported. Analyses show reductions as high as 80% in the amount of odorous sulfur compounds, particularly hydrogen sulfide in the recovery furnace stack. Adoption of this process by southern United States kraft mills has been hindered by the severe foaming properties of black liquor from this region. Fones (*60*) investigated a method of oxidizing the liquor in a pressure vessel with pure oxygen as a possible means of over-coming foaming. While the rate of oxidation of the liquor at elevated temperatures was found to be quite rapid, the cost was found to be prohibitively high. West (*61*) found that the overall oxidation efficiency of multiple towers could be significantly improved by operating them in series rather than parallel flow. There were also indications that the capacity coefficient for a given tower packing increases with increasing liquor flow rates.

A manual dealing with various air pollution aspects of solid fuel combustion has been distributed by the National Council for Stream Improvement to it member mills (*62*). The manual, which deals with the legislative aspects of air pollution and methods of compliance with various control codes, was prepared by the Research Division of New York University. A section on measurement of atmospheric pollutants and incineration is also included.



FOR THE PAPER INDUSTRY SANDY HILL PRODUCES:

Breast Rolls
Table Rolls
Fin Rolls
Wire Return Rolls
Lumpbreaker Rolls
Fly Rolls
Blow Rolls
Couch Rolls
Cylinder Moulds
Distributor Rolls
Felt Carrier Rolls
Granite Rolls
Dryers
Yankees
Cooling Cylinders
Dryer Felt Rolls
Spring Rolls
Reel Drums
Reel Spools
Miscellaneous Rolls
Also Roll Grinding and Rolls for other industries.

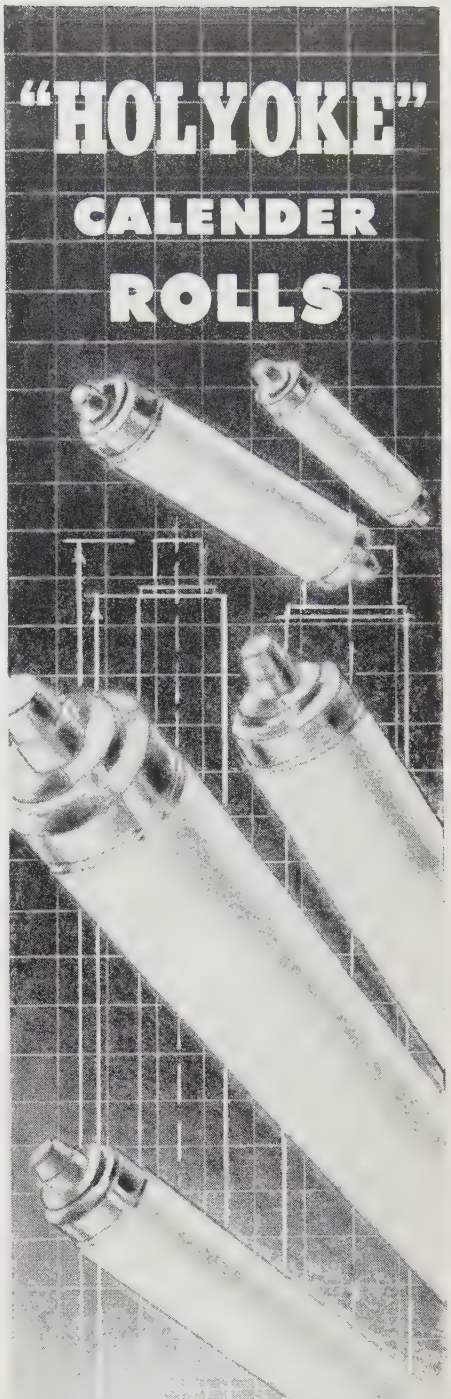
At Sandy Hill every operation in the manufacture of a paper machine roll is in the hands of able and experienced engineers and mechanics. These designers and builders are backed by the company's hundred year history of service to the paper industry.

Each paper machine roll is designed for its particular function in the papermaking process, and manufacturing operations conform to the highest standards to assure rolls of the finest quality.

THE SANDY HILL IRON AND BRASS WORKS
HUDSON FALLS, N. Y.

LITERATURE CITED

1. "Papers Presented at the Pulp, Paper and Paperboard Industrial Waste Conference Held at Chicago, Ill., Dec. 1–2, 1959." *Pulp Paper Mag. of Can.* 61, No. 2: T34; 61, No. 3; T186 (1960).
2. Bowers, R. T. and Wells, C. C., Jr., *Chem. Processing* 23, No. 6: 84 (1960).
3. Anon., "Largest Activated Sludge Plant for Pulp and Paper Wastes Will Treat Sewage From Three Towns." *Wastes Eng.* 31, No. 4: 196 (1960).
4. "Symposium on Sulfite Pulping and Recovery Systems." *Tappi* 42, No. 8: 673, (1960).
5. Anon., "New Capacity for Spent Sulphite Liquor Products at Lignosol Chemicals," *Paper Trade J.* 144, No. 37: 46 (1960).
6. Anon., "By-Products from Spent Sulfite Liquor Solids." *Pulp & Paper* 34, No. 13: 79 (1960).
7. Perry, F. G. Jr., Canty, C., and Voci, J. J., *Purdue Univ. Eng. Bull. Ext. Ser.* No. 104: 200 (1960).
8. Holderby, J. M. and Moggio, W. A., *Water Pollution Control Federation*, 32, No. 2: 171 (1960).
9. Opderbeck, F., Franke, E., and Trapp, G., Canadian pat. 566,371; *B.I.P.C.* 29: 1098 (1959).
10. Cirillo, V. P., Hardwick, W. A., and Seeley, R. D., U. S. pat. 2,928,210. Filed Jan. 13, 1958. Issued March 15, 1960. Assigned to Anheuser-Busch.
11. Cormack, J. F. and Amberg, H. R., *Purdue Univ. Eng. Bull. Ext. Ser.* No. 104: 16 (1960).
12. Marczek, E., and Zielinski, J., *Przegl. Papiern.* 13, 245 (1957): *Water Poll. Abst.* 33: 279 (1960).
13. Buehler, J. M., *Tappi* 43, No. 1: 164A (1960).
14. Woodworth, E. A., *Tappi* 43, No. 4: 177A (1960).
15. Stops, F. P. T. and Agar, J. R., *Australian. P.P.I.T.A.* 13, No. 2: 19 (1959).
16. Laws, R. L. and Burns, O. B. Jr., *Purdue Univ. Eng. Bull. Ext. Ser.* No. 104: 633 (1960).
17. National Council for Stream Improvement, Tech. Bull. No. 131 (May 31, 1960).
18. Doughty, J. B. and Cook, W. R., U. S. pat. 2,864,811 (to West Va. Pulp & Paper Co.); *B.I.P.C.* 29: 1240 (1959).
19. Othmer, D. F., U. S. pat. 2,878,283.
20. Flynt, J. W. and Suda, S., U. S. pat. 2,879,838 (to Babcock & Wilcox Co.).
21. Gummels, H., *Papier*, Darmstadt, 12: 385 (1958); *B.I.P.C.* 29: 1049 (1959).
22. Tifft, A. H., *Tappi* 42, No. 11: 884 (1959).
23. Anon., "Waste Pulp Recovery." *Indian Pulp & Paper* 13, No. 2: 125 (1958): *B.I.P.C.* 29: 1145 (1959).
24. Klebanoff, G., Jr. and Bueltman, C. G., *Tappi* 43, No. 3: 234A (1960).
25. Quirk, T. P., *Wastes Eng.* 31, No. 2: 82 (1960).
26. Klinger, L. L., *Tappi* 43, No. 7: 669 (1960).
27. Nadelman, A. H. and Newton, L. P., *Tappi* 43, No. 2: 120 (1960).
28. Blosser, R. O., *National Council for Stream Improvement Tech. Bull.* No. 136 (Nov 23, 1960).
29. National Council For Stream Improvement, *Tech. Bull.* No. 135 (Nov. 21, 1960).
30. National Council for Stream Improvement, *Tech. Bull.* No. 130 (May 27, 1960).
31. Blosser, R. O., *Tappi* 43, No. 5: 454 (1960).
32. O'Connor, D. J. and Eckenfelder, W. W. Jr., *J. Water Pollution Control Federation* 32, No. 4: 365 (1960).
33. Egan, J. T. and Sandlin, M., *Ind. Wastes* 5, No. 4: 72 (1960).
34. Waldmeyer, T., Proc. Brit. Paper Board Makers Assn., 39: 425, 1958; *Water Poll. Abs.* 33: 67 (1960).
35. Anon., "No-Waste Chemical Pulping," *Chem. Process Eng.* 41: 3 (1960).
36. Taga, Nobuo, Tabata, Kenji and Ozawa, Kunio, *J. Japan Tech. Assoc. Pulp Paper Ind.* 13, No. 9: 650 (1959).
37. Desrochers, R. and Fredette, V., *Can. J. Microbiology* 6, No. 3: 349 (1960).
38. Chambon, M., *L'Eau*, 47: 7 (1960); *Public Health Eng. Abs.* 40, No. 11: 97 (1960).
39. Wilson, J. N., Wagner, R. A., Toombs, G. L., and Becher, A. E. Jr., *Water Poll. Control Fed.* 32: 83 (1960).
40. Zieminski, S. A., Goodwin, C. G., and Hill, R. L., *Tappi* 43, No. 12: 1029, 1960.
41. Wiley, A. J. and Lueck, B. F., *Tappi* 43, No. 3: 241 (1960).
42. Dillingham, E. O. and Jose, A. G., *Tappi* 43, No. 7: 626 (1960).
43. Tabak, H. H., Chambers, C. W., and Kabler, P. W., *J. Bacteriology* 78: 469 (1959).
44. Adams, D. F., Koppe, R. K., and Jungroth, D. M., *Tappi* 43, No. 6: 602 (1960).
45. National Council for Stream Improvement, *Atmospheric Pollution Tech. Bull.* No. 13 (Sept. 26, 1960).
46. National Council for Stream Improvement, *Atmospheric Pollution Tech. Bull.* No. 14 (Oct. 20, 1960).
47. Welch, A. F. and Terry, J. P., *Am. Ind. Hyg. Assoc. J.* 21: 316 (1960).
48. Hands, G. C. and Bartlett, A. F. F. *Analyst* (London) 85: 147 (1960); *APCA Abs.* 6: 3401 (Dec., 1960).
49. Gruber, C. W., Jutze, G. A., and Huey, N. A, *J. Air Poll. Control Assoc.* 10, No. 4: 327 (1960).
50. Huey, N. A., Broering, L. C., Jutze, G. A., and Gruber, C. W., *J. Air Poll. Control. Assoc.* 10, No. 6: 441 (1960).
51. Rabkin, S. and Crommelin, P. B., *Paper Trade J.* 144, No. 16: 48 (1960).
52. Lagarias, J. S., *J. Air Poll. Control Assoc.* 10, No. 4: 271 (1960).
53. Murray, J. S., *Tappi* 43, No. 11: 899 (1960).
54. First, M. W., Friedrich, H. E., and Warten, R. P., *Tappi* 43, No. 6: 182A (1960).
55. Semrau, K. T., *J. Air Poll. Control Assoc.* 10, No. 3: 200 (1960).
56. Fenwick, T. L. and Thomas, J. W., *Pulp Paper Mag. Can.* 61, No. C. T161–6 (Convention Issue, 1960).
57. Jurgensen, H. D., Jacoby, H. E. and Lankenau, H. G., *Tappi* 43, No. 6: 193A (1960).
58. O'Brien, J. F., *Paper Mill News* 83, No. 48: 34 (1960).
59. Anon. "Western Kraft Deodorizing Mill," *Paper Mill News* 83, No. 37: 28 (1960).
60. Fones, R. E. and Sapp, J. E., *Tappi*, 43, No. 4: 369 (1960).
61. West, W. B., *Tappi* 43, No. 10: 192A (1960).
62. National Council for Stream Improvement, *Atmospheric Poll. Tech. Bull.* No. 12 (April 6, 1960).



Designed . . .

by experienced engineers and built by skilled craftsmen to meet today's exacting specifications and requirements.

SINCE 1863

HOLYOKE MACHINE COMPANY

CALENDER and EMBOSSING ROLLS
for the PAPER and TEXTILE INDUSTRIES
WATER FILTRATION EQUIPMENT
HOLYOKE, MASSACHUSETTS

Gravure Inks in Relationship to Printing Surfaces

W. S. WEBSTER

This paper describes the paper or board surface most desirable for quality gravure printing. A brief description of gravure ink formulation and manufacture is followed by an explanation of actual deposition and drying of a gravure ink. The general lack of knowledge on the part of ink formulators with regard to specific coatings on which the ink will be printed is discussed. It is pointed out that if it were possible to make reference to a specific coating, the future formulation of inks would be greatly simplified.

In presenting a paper relating gravure inks to paper and boxboard, we feel some ground should be covered by way of describing the basis of general gravure formulation and some of the manufacturing techniques.

First of all, most gravure inks are, in the simplest possible terms, a volatile solvent solution of a binder in which there are dispersed pigments or dissolved dyes. The term binder, as it is used here, refers to all the nonvolatile components in the formula other than colorants or fillers, and this constitutes the most complex part of ink formulation. It would be impossible to name more than a small part of the hundreds of materials that can make up a binder, but some of the general types of raw materials will cover enough ground for our purposes at this time.

FORMULATION

Binders are the starting point for ink formulation, and film formers are generally the starting point in developing a binder, although not always.

The most common of the film formers are nitrocellulose and parlon, which are the bases for the C and T type inks, respectively. The film former can be modified in many ways through the addition of resins, plasticizers, and waxes, but these three items represent only the more common modifiers and, technically, would be supplemented by a great number of other types of materials. It has been previously stated that the film formers are generally the starting point for binder formulation, but this is not always the case, and large volumes of ink are made without incorporation of film forming resins but based on natural or modified natural resinous materials usually lacking film integrity but having desirable properties of pigment wetting and/or solvent release that make them suitable for printing jobs where "special properties" in the finished print are not of primary concern. "Special properties" would mean product resistance, rub resistance, heat resistance, and other requirements that are usually expected in the packaging industry.

Formulation of a binder is completed to the end of producing an ultimate in the properties demanded and/or handling, consistent with reasonable economics. In itself, formulation may be affected by the type of pigments used and how they are to be dispersed.

It would not be reasonable to contemplate the various reasons for the particular method of pigment dispersion selected, since the reason might be technical, economic, or expediency.

Dispersion is often associated with the term "grinding," which is in itself somewhat of a misnomer since actually the majority of the work done on pigment is a breaking up of agglomerates and not a reduction of actual particle size as such, or at least to a negligible extent.

Most commonly utilized methods are steel ball and pebble mill grinding which disperse by attrition, and two and three-roll mill dispersing by shear. There are a number of other methods including colloid mixers, sand grinders, and dough mixers, which all have their place in ink manufacture but do not carry the major volume of production.

We grant this description of gravure ink is, at best, only skimming the surface, but it does convey some concept of the principles of manufacture and formulation, where a deeper discussion concerned with specific components or dispersion methods might lend to confusion and digress a good deal from our goal of tying together the relationship of gravure ink and board surface and how they may supplement each other.

A gravure ink dries or "sets" when the volatile portion, or solvent, evaporates. The film remaining on the stock surface represents the finished product as the chemist formulated, and in actuality is the binder with colorant and with the properties built in during formulation.

PRINTING

Now, gravure ink usage differs from other processes in that the instant the printed stock leaves the printing nip it is in a liquid state and of sufficient volume that it is free to submit to a pattern in the seconds or fraction of a second that it remains as a liquid before drying has proceeded to a point where there is no longer any flow possible.

What the ink may do after deposition, as well as the amount of ink that is transferred from the cells of the gravure etch, is dependent on the affinity of the ink for the particular surface in question, as well as other factors, such as absorbency, but we feel this point is the most pertinent at issue.

The chemical nature of the stock surface is primarily responsible for the ink affinity or receptivity. The control a board or paper mill has of this "chemical nature" depends, in large part, on whether the stock is considered coated, sized, or just calendered, and the three terms represent a matter of degree of control. The less the coating or size present, the less the variable possible, not necessarily of printability or quality but of variable.

Very likely, it is not only possible but probable that nearly identical surfaces might be produced with entirely different materials from the standpoint of brightness, gloss, slip, absorbency, and smoothness, as well as other properties; and, yet, one surface will have excellent receptivity to a given ink and print "high quality," while the other will present a surface that is nearly impossible to print with the same ink. It is here that the ink formulator needs the assistance of the pulp and paper industry.

Years ago, we thought that a casein coating was the ideal for gravure printing while starch presented a real problem situation. Then, with more experience working on both types of surface coatings, it was found that certain casein coated surfaces could be next to impossible and very excellent starch surfaces were encountered.

At that point we recognized the fact that paper and board coatings were not just casein, or starch, or whatever, but

W. S. Webster, Commercial Ink & Lacquer Co., Fair Lawn, N. J.

rather were developed formulas just as are inks. It was recognized that each coating formula was modified in a number of ways by a multitude of raw materials and that the chemical nature of each bore no necessary relationship to some other surface that may have been coated with a material referred to by the same general term. With this knowledge it became a general practice to produce a printable ink through trial and error, by which approach we were able to determine a general direction in which to direct our efforts. Some surfaces have proved themselves to be poor printers, no matter how much time and effort is expended in developing a particular ink, while others present a surface that may be printed with a variety of common ink types or formulas and yield equally good print quality and properties.

It is in this area that help from your industry might be the most rewarding. Naturally, we do not expect that specific ingredients be revealed, any more than we would reveal the formulas for our inks. However, a program on your part for recording the general type of ink that was deemed effective on one or the other of the various stocks would be expedient for both of us as a service to our customers, which in our case are very often yourselves. By the same token, we would be better able to serve the industry if there were a way of telling us the nature of the coating without being so specific as to jeopardize your confidences or so general as to be useless to the inkmaker.

We have thus far only mentioned two general and long-established coatings, but we recognize the great variety currently in use and, in many cases, the particular problems peculiar to their categories.

We have encountered the acrylic, styrene-butadiene, polyvinyl alcohol, and soy protein-type binders, as general terminology would have it, but in each case the ultimate printing properties are dependent on various modifications. Therefore, we cannot predict that X, Y, or Z ink will print favorably on a PVA coating or a styrene-butadiene coating simply because it is PVA or styrene-butadiene by name.

SPECIAL COATINGS

We are faced with the same problem here as with starch and casein, in that we just cannot predict what printing quality will be, based on knowledge of the general type of coating. Were we able to set up some exchange of information, as mentioned previously, so that we would have reference to a specific coating and you to ink type, the whole packaging industry would benefit by virtue of eliminating nearly all the trial and error testing necessary to select the proper ink for a given job. The type of coating you select is determined by properties other than printability in many cases, and we are not suggesting that it should be any different. We do think that in many cases where printing difficulties are encountered due to coating it would be entirely possible to use an alternate coating and still retain the properties necessary, while providing a surface favorable to gravure printing.

Probably the most frustrating situation we run into is that of running a process job on a physically rough surface and one that tends to be hard. Even with the most receptive coated surface possible and the right ink for the coating, we can be completely stymied by rough stock.

We know what we want in the way of stock surface, but we are also aware that under the particular circumstances of a given job it is not always possible to achieve the quality we would like to have.

Certainly, line work is not as critical as a process job since, generally, we are depositing enough ink to take care of the minor stock irregularities.

A natural unbleached kraft as produced by a fourdrinier machine or even a hard cylinder board is difficult to print. These surfaces are so hard that we are not able to compress them with the impression pressures available, and we do have to make contact with the stock in order to print.

It is for this reason that soft stocks usually print well since we are able to compress them and bring the etched surface into contact with the stock surface. A soft, absorbent stock will yield good ink lay and print fine halftones if the absorbency is uniform, but as a rule the gloss or finish of the ink is poor.

Gloss can be most materially improved by coating the board with a nonabsorbent size, and then we create other problems such as "spill-out" and sometimes poor scratch or adhesion. A size that normally produces a good printing surface can cause severe scratch and adhesion problems if too heavy a deposit exists. We know PVA and CMC can cause these problems, but by the same token if lesser deposits are applied, the sheet will print well with good adhesion although with some sacrifice of gloss. We deduce then that it is not only the kind of coating we are concerned with but the amount of deposit as well.

Certainly, the most difficult stocks to prepare for gravure printing are the naturally rough, hard surfaces as personified by unbleached fourdrinier kraft, and pursuant to this topic we have found that a trailing blade knife coating best prepares the surface for printing. This principle seems to apply generally, whether the coater is off or on machine, or in line with the printing equipment. The trailing blade has been found to apply to board stock in general, and is not limited to natural kraft specifically. We feel this has a lot of logic, since what we are trying to accomplish, in effect, is a filling up of the depressions that exist in a stock surface and thereby producing a smooth printing surface.

Admittedly, the ultimate in esthetic appearance is not achieved by use of a trailing blade, but through applying an excess of the size and scraping if off with a blade we are able to "level" a sheet.

The amount of coating is limited with a trailing blade, but very likely a second size unit, say an air knife, would accomplish the level surface plus the amount of size necessary to seal a sheet to a degree where good printing is apparent in all respects.

One other point that should be mentioned is "pick test." We have not stressed pick at any time as pertaining to gravure printing, and yet it cannot be wholly ignored. Most certainly, it is not as critical in gravure as it is with letterpress and/or offset, but, on the other hand, it cannot be ignored.

A low enough pick can contribute a great deal to paper dust accumulation in the ink by virtue of transfer to the printing cylinder, and, as well, can frequently be responsible for severe streaking problems. In other words, the coating must be bound to the sheet and not transfer to the cylinder where it may well cause immediate streaking or, at best, build up in the ink to a degree where any number of problems can develop.

We do not know what problems may be attributed to pick, and to our knowledge the question has not been fully investigated. Perhaps it should be, and limits set up for the industry to apply.

Basically, what we would like to have is a smooth surface on which to print, and one which has "hold-out" or lack of absorbency, but not to the extent of creating adhesion, scratch, or spill-out problems. Further, we would like a coating that has a potential receptivity to some of the generally used gravure inks.

All this may sound like a large order, and we do not mean it as such, but rather an indication on our part of what we feel to be the most advantageous working agreement between ink and stock.

We do not expect such a surface each time we set an ink system on a job, but any efforts that can be made toward this will be most welcome, and our industry as a whole is ready to cooperate in any way possible.

Received Jan. 18, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

Paper Mill Boiler Feedwater Practices

M. H. BORLAND

Quantitatively, the water used in the steam generating cycle of a modern paper mill is a small part of the total amount used. For reliable, continuous operation of the mill it is essential that the returned condensate and make-up water be properly treated. This treatment will allow boilers to operate the full year between inspections without excessive scale or other conditions forcing unscheduled outages. This treatment will allow turbines to operate several years without excessive blade deposits or other problems caused by steam conditions. The proper treatment will also minimize scaling and pitting of steam heating equipment and condensate return lines. The higher temperatures and pressures of modern boilers accelerate chemical reactions. This requires that more care be given to the treatment used and that it be held within closer limits. The purpose of this paper is to describe the steam generating system of a large paper mill and the different types of feedwater treating methods at various pressures and temperatures.

THE subject of this forum is certainly of vital interest to the paper industry. Of necessity, there is a great mass of literature on the subject. On the one aspect of boiler water there is much detailed information available. Rather than attempting a detailed analysis of any one aspect of the boiler feedwater system it is the purpose of this paper to discuss the general problem as faced by one plant and the methods used in meeting it.

What are the qualities that are desired in the water used in the steam generating cycle?

1. It should be softened to prevent scale formation in the boiler. The most common sources of boiler scale are calcium and magnesium salts. The insulating effect of a scale deposit will cause as much as from 10 to 12% reduction in heat transmission. This easily leads to overheating of the tube metal and subsequent tube failure.
2. It should be deaerated to prevent corrosion in the boiler and steam using equipment. The tendency for oxygen and dissolved carbon dioxide to attack steel is accelerated at boiler water temperatures.
3. It may be necessary to treat to reduce the tendency to cause carry over of solids with the steam. A special treatment to prevent carryover is not needed in all cases. Where the tendency is present, treatment is essential.
4. The proper ratio of sodium nitrate to sodium hydroxide to prevent caustic embrittlement must be maintained.

The most desirable source of boiler feedwater is returned condensate. In most industrial plants steam is used for space heating and process use. A considerable amount of condensate is lost and does not return to the cycle. "Make-up" water must be added to the cycle for the condensate so lost.

The Chillicothe Div. of The Mead Corp. generates approximately 750,000 lb. per hr. of steam at three pressure levels—200, 400, and 900 p.s.i. The electric system generates approximately 33,000 kw. at four voltage levels—600 v., 2300 v., 4160 v., and 13800 v. Steam is extracted from the turbines at 150 and 30 p.s.i. for process use. The power system has been expanded in line with the increased production of the mill. As the state of the art of generation advanced, we have gone to ever higher steam pressures and temperatures. The 200 p.s.i. pressure system was installed in 1926. When the system was next expanded in the early 1930's the 400 p.s.i. pressure system was installed. Since World War II two recovery boilers and a 250,000 lb. per hr. coal fired boiler have been installed at the 900 p.s.i. pressure level.

MATTHEW H. BORLAND, General Power Superintendent, Chillicothe Division The Mead Corp., Chillicothe, Ohio.

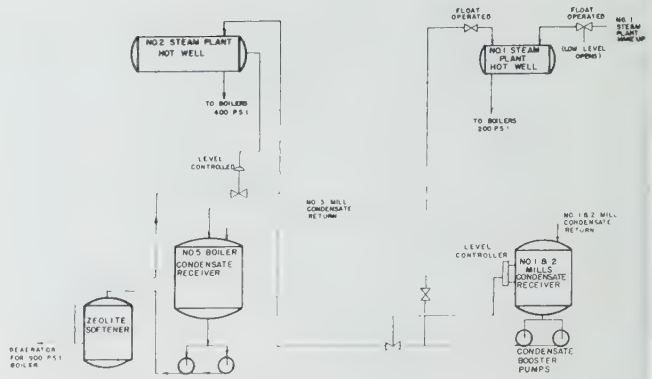

NO.2 STEAM PLANT HOT WELL
TO BOILERS 400 P.S.I.
LEVEL CONTROLLER
NO.5 BOILER CONDENSATE RECEIVER
ZEOLITE SOFTENER
DEAERATOR FOR 900 P.S.I. BOILER
NO.1 STEAM PLANT HOT WELL
TO BOILERS 200 P.S.I.
NO.1 STEAM PLANT MAKE-UP
NO.1 & 2 MILLS CONDENSATE RECEIVER
CONDENSATE BOOSTER PUMPS

Fig. 1. Condensate distribution system

With only the two lower pressure plants in operation, each had its individual feedwater systems and they were operated as two separate units. When 900 p.s.i. pressure, 850°F. temperature boilers were installed, it was decided to operate the entire feedwater system as a unit. The purpose of this was to give the high pressure boilers the greater percentage of return condensate for feedwater and to operate the lower pressure units with a high percentage of makeup water. To accomplish the proper control and division of returned condensate, all three pressure systems were connected as shown in Fig. 1.

The level controller in the nos. 1 and 2 mill condensate receiver operates a valve in the line to the no. 5 boiler condensate receiver. Above a present level, the valve opens allowing condensate from nos. 1 and 2 mill to be pumped to the no. 5 boiler condensate receiver. The makeup water at the 200 p.s.i. pressure boilers averages 49%. The no. 5 boiler condensate receiver supplies the feedwater to both the 400 and 900 p.s.i. pressure boilers. The makeup water in this system averages 20%.

The treatment of boiler feedwater is similar in some respects in both the high and low pressure systems. The treatment for the high pressure system is much more extensive. The hot process lime-soda softener is used for makeup water in the 200 p.s.i. pressure system. The term hot process is used when the water to be treated is near or above the boiling point. The softening may also be carried out as a cold process at the normal temperature of the raw water. The softener flow diagram is shown in Fig. 2. There are four essential factors for this process:

1. Proper selection of the specific reagents to precipitate

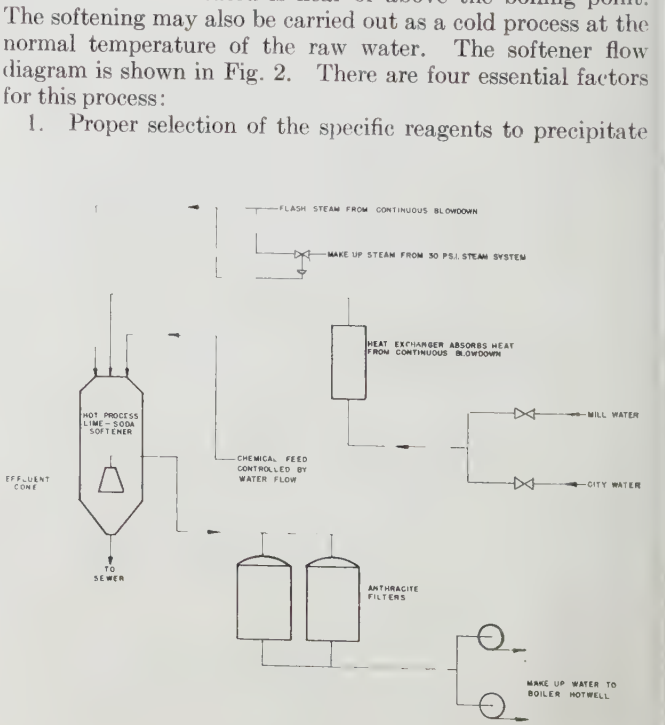

FLASH STEAM FROM CONTINUOUS BLOWDOWN
MAKE UP STEAM FROM 30 P.S.I. STEAM SYSTEM
HEAT EXCHANGER ABSORBS HEAT FROM CONTINUOUS BLOWDOWN
HOT PROCESS LIME-SODA SOFTENER
EFFLUENT CONE
CHEMICAL FEED CONTROLLED BY WATER FLOW
MILL WATER
CITY WATER
TO SEWER
ANTHRACITE FILTERS
MAKE UP WATER TO BOILER HOTWELL

Fig. 2. No. 1 steam plant (200 p.s.i.) water softener

part of the impurities as an insoluble sludge and to convert the remainder to a soluble form.

2. The reagent must be properly proportioned for the raw water used.

3. The precipitating reaction must be carried out by a suitable combination of coagulation, sedimentation, and heat.

4. The softened water must be properly filtered to remove turbidity resulting from the process.

This process is carried out in a softening tank which provides a means of heating the water and adding chemicals proportional to the amount of raw water. The chemicals and water are thoroughly mixed. A coagulant aid, sodium aluminate, is added to speed the settling of solids and reduce the load on the filters. Solids precipitated in the softener must be removed periodically. The principal chemical reactions follow:

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O \quad (1)$$

$$Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow Mg(OH)_2 + 2CaCO_3 + 2H_2O \quad (2)$$

These reactions result in a reduction of total solids. Reaction of lime and noncarbonate hardness precipitates magnesium hydroxide but also forms soluble by-products:

$$MgSO_4 + Ca(OH)_2 \rightarrow Mg(OH)_2 + CaSO_4 \quad (3)$$

$$MgCl_2 + CaOH \rightarrow Mg(OH)_2 + CaCl_2 \quad (4)$$

Soda ash reacts to remove the noncarbonate hardness but leaves sodium sulfate and sodium chloride as soluble by-products. These reactions do not result in a reduction of total solids:

$$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + Na_2SO_4 \quad (5)$$

$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl \quad (6)$$

Following the lime-soda softener, the treated water is put through a pressure filter. Since silica is readily soluble in a hot alkaline solution, anthracite is used for the filtering medium.

There is a retention time of approximately 1 hr. in the lime-soda softener. The water leaves with hardness reduced to a range of 10 to 30 p.p.m. as calcium carbonate. This water is pumped directly to the hot well and then to the feedwater heater. This part of the cycle is shown in Fig. 3. Chemicals for internal treatment are added in this section of the cycle. A blend of lignin types of organic salts is added ahead of the hot well. Its chief purpose is to reduce scale formation by conditioning the solids in the water and making it less likely to form scale. The active component is an alkali-soluble derivative of lignin containing carboxyls and phenolic hydroxyls as the functional groups. The exact way in which

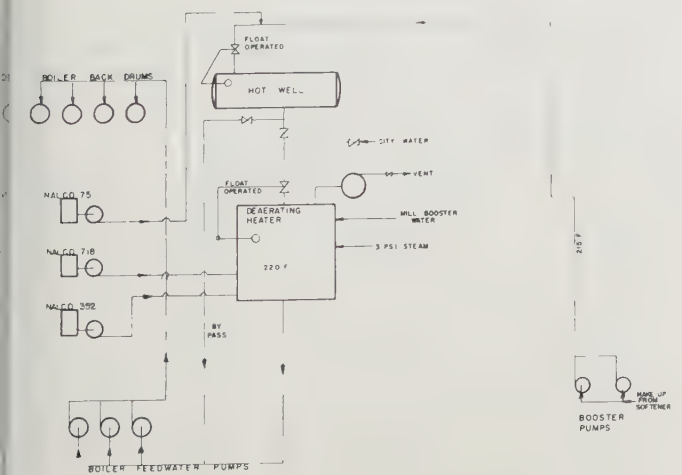


Fig. 3. No. 1 steam plant (200 p.s.i.) feedwater system

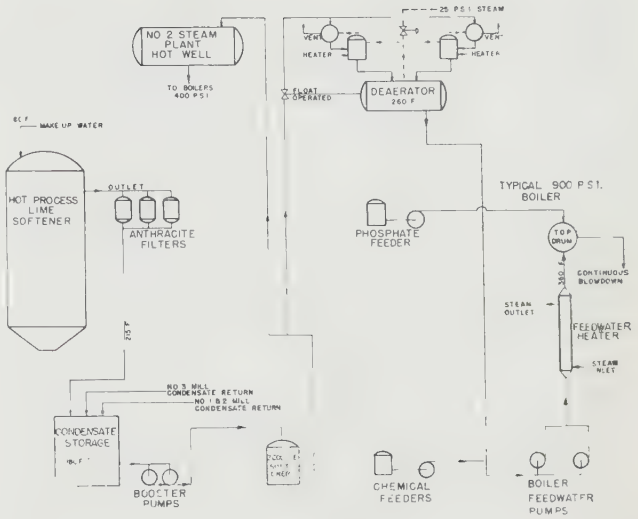


Fig. 4. 900 p.s.i. boiler feedwater system

these organic components have this effect is not fully understood. Two theories have been offered:

1. The lignins coat the crystals of calcium and magnesium salts and prevent growth.

2. The lignins take part in a colloidal reaction causing dispersion or coagulation of scale-forming crystals.

A polyphosphate treatment is added at the feedwater heater. The phosphate reacts with calcium hardness to prevent scale formation. The formulation used also contains lignin-type organic material for further sludge conditioning.

Conditions in the high pressure boilers are more extreme and the requirements for boiler feedwater are more critical. In this system all makeup water passes through a hot process lime softener. The reaction here is similar to part of that in the hot process lime-soda softener. The lime reacts with carbonate hardness to reduce solids content through precipitation. The lime also reacts with noncarbonate hardness to precipitate magnesium hydroxide but also produce soluble by-products. This makeup water then passes through an anthracite filter to the condensate storage tank. In this tank is also collected all the returned condensate. This system is shown in Fig. 4. The combined makeup water and returned condensate is passed through a sodium zeolite softener.

The zeolite softener is a comparatively new process and is used in many applications where soft water is needed. Its use is constantly being expanded. The sodium zeolite softening process exchanges sodium ions for cations of two or more positive charges. When water containing calcium and magnesium salts pass through the cation exchange bed, the sodium ions replace the hardness ions. The effluent water is close to zero hardness. There is no reduction in the solids content of the water.

Natural zeolite materials usually consist of sodium aluminum silicate. Synthetic zeolites may have bases of sulfonated coal, phenolic resins, or polystyrene resins. In any case, it is possible to represent the zeolite in a chemical reaction as Na_2Z, where Z represents the complex zeolite radical. Thus, the basic reaction in zeolite softening is

$$Ca^{++} + Na_2Z \rightarrow CaZ + 2Na^+$$

When the reaction proceeds to the point where no more sodium ions can be released, the zeolite bed is regenerated by washing with a strong salt solution. The high concentration of sodium ions reverses the reaction as follows

$$CaZ + 2NaCl \rightarrow Na_2Z + CaCl_2$$

Following the zeolite softener, the water passes through the deaerator to the boiler feed water pump, through the feed water heater and then to the boiler.

In this part of the cycle the internal chemical treatments are added. As in the lower pressure boilers, a blend of lignin type organic salts is added. Again, the purpose is to reduce scale formation by conditioning the solids in the water and make it less likely to form scale. A polyphosphate treatment is added in the boiler drum. As in the low pressure boilers, its purpose is to react with any remaining calcium hardness to reduce scale formation.

Further chemicals are added to the high pressure system which are not found in the lower pressure boilers. Sodium hydroxide and sodiun nitrate are added to act as a caustic embrittlement inhibitor. Caustic embrittlement of boiler metals is an intercrystalline cracking. This cracking may cause dangerous weakening leading to boiler failure. This process was not understood at first and lead to many accusations of faulty workmanship and design. Although the process is not yet fully understood, it is known that three factors are necessary. Leakage must occur to permit the escape of steam and a concentration of boiler water. The metal must be highly stressed due to cold working or expansion or contraction. The concentrated water must have embrittling characteristics and chemically attack the metal.

Since the operator has no control over the first two requirements, the practice is to treat the water to remove any embrittling characteristics. When sodium nitrate is added and the proper ratio of sodium nitrate to sodium hydroxide maintained, the boiler water will not cause embrittlement.

A treatment of catalyzed sodium sulfite is added ahead of the feedwater heater. This will react with any dissolved oxygen to form sodium sulfate. A catalyst is added to increase the reaction speed. This treatment is to remove any trace of oxygen remaining following the mechanical deaeration. A slight residual of sodium sulfite is held in the water. This assures that all dissolved oxygen has been reacted.

The problem of oxygen corrosion becomes increasingly important at higher temperatures. The action becomes much more rapid. The corrosion is most severe in closed feedwater heaters and economizers where dissolved oxygen has no opportunity to come out of solution and carry over with steam as in the boiler drums. The corrosion takes the form of pitting so that failure may occur even though most of the metal remains.

Any open feedwater heater will produce some deaerating. The open feedwater used in the 200 p.s.i. pressure system will reduce the dissolved oxygen content to about 0.3 cc. per l. The deaerating heater as used in the 400 p.s.i. pressure system reduces the dissolved oxygen content to 0.03 cc. per l. The deaerator used in the 900 p.s.i. system reduces the dissolved oxygen to 0.005 cc. per l.

This mechanical deaeration follows the principles of two of the gas laws. Dalton's law states that the total pressure of a mixture of gases is equal to the sum of the pressure each gas would exert alone in the same volume. Henry's law states that the concentration of a dissolved gas is directly proportional to the partial pressure of that gas above the solution.

In the deaeration process steam is thoroughly mixed with the water. The heating of the water causes much of the dissolved gases to come out of solution. Steam fills the area above the water. By thorough venting, the partial pressure of the dissolved gases is lowered and more dissolved oxygen comes out of solution. The difference between an open feedwater heater, a deaerating heater, and a deaerator is in the mechanical design which determines the amount of intimate mixing of the steam and water and the thoroughness of venting.

As was mentioned previously a chemical deaerator is added ahead of the boiler to remove any trace of oxygen remaining from the mechanical deaeration.

Another function of the lignin type of organic salts which are added is to reduce any tendency of the boiler water to carry over with the steam. Carryover is defined as the continuous entrainment of small amounts of boiler water with the steam. Special forms of carryover are foaming and priming. Foaming is the formation of bubbles on the water surface. It may be a relatively thin layer or may fill the entire boiler drum. Priming is a violent surging of the drum water which may result in slugs of water carrying over. This condition is similar to the bumping action when water is boiled rapidly in an open container.

There are a number of factors which may produce a tendency for carryover of boiler water. It is difficult to predict from chemical analysis and it is usually determined from operating experience.

As mentioned in other sections, water entering the feedwater cycle has heat added before the boiler itself. In the lime softener or lime-soda softener the heat increases the speed of the chemical reactions. In the deaeration process heat aids in the removal of oxygen and carbon dioxide. Another important factor is the increase in efficiency of the boiler due to feedwater heating. For each 10°F. increase in feedwater temperature there is approximately 1% savings in fuel requirement. This heating is done with low pressure exhaust steam whose energy content would be difficult to recover otherwise. When the boiler and auxiliaries are being selected, an economic study must be made to determine the amount of heating to be used. In general, as steam conditions become higher it is desirable to use more feedwater heating.

The heaters mentioned thus far are all of the open type in which steam is mixed directly with the water. In the 900 p.s.i. boilers, the feedwater also passes through a closed heater which is a tube-type heat exchanger. This heater does no deaeration. It offers the advantage that impurities such as oil which may carry over with the steam are not recirculated back with the feedwater.

As steam passes through the heating system and process uses, oxygen and carbon dioxide can readily be dissolved in the returned condensate. Through a series of reactions, deposits of FeO, Fe_2O_3, Fe_3O_4, $FeCO_3$, and mixtures of these may be found in condensate return lines. These reactions result in pitting and grooving in all parts of the condensate return system. In an effort to reduce corrosion in our condensate return system, experiments have been started with the addition of the volatile amine morphaline. The morphaline is added to the boiler feedwater. It is volatilized and carries over with the steam. It tends to neutralize the corrosive process. This treatment has been used for too short a time to make any definite conclusions as to its effectiveness in our plant. This is a well established treatment, however, and a definite reduction in return line corrosion is expected. This entire system of treatment to be effective must be properly controlled. Simple tests have been set up to be made by operating personnel. These tests indicate changes in chemical treatments made necessary by any changes in water composition.

Daily a laboratory technician verifies the test results and may change the chemical treatment. He will also trouble shoot any problem indicated by improper test results.

Periodically a feedwater consultant reviews the operating procedure and recommends changes in treatment.

The ideal steam generating cycle would be a closed system in which all condensate was returned. The only need for makeup water would be to supply that lost through blow down of the boiler. In a typical paper mill a large part of the steam generated is used for process heating and does not return to the cycle.

The addition of a considerable amount of makeup water requires chemical treatment to give the water the proper characteristics. In the hot process lime softener solids are actually precipitated from the water. Further treatments alter the chemical composition and physical characteristics of solids in the water. Water enters the 900 p.s.i. boilers with 40 to 50 p.p.m. dissolved solids. The solids content will be higher in the lower pressure boilers.

As water evaporates the dissolved solids will concentrate in the boiler. To prevent the solids content reaching too high a level, a small per cent of the water in the boiler drum is continuously drained off. The amount of blowdown required is determined by the dissolved solids content of the boiler water.

This has been a brief review of boiler feedwater treatment as a part of the steam generation cycle. The specific treatments referred to are those used in one plant. The treatment will vary in some detail for each boiler house. This will depend on such factors as the boiler temperature and pressure, the type of water available for makeup, the use made of the steam and amount of condensate lost from the cycle.

Presented at the 11th Testing Conference of the Technical Association of the Pulp and Paper Industry, held in Grand Rapids, Mich., Sept. 27–29, 1960.

A Preliminary Report on a New Fourdrinier Wire Weave

JAMES E. WATSON

Research on the basic construction of the fourdrinier wire was undertaken with an effort to improve paper finishes and physical characteristics. The results of the research were the development of an entirely new weave of fourdrinier wire, capable of producing improved paper finishes and materially improving basic paper characteristics. The new fourdrinier wire itself also has numerous advantages over the conventional weave. Preliminary field tests indicate a substantially improved media for the formation of paper and a substantially improved fourdrinier wire, which are expected to provide a marked decrease in operating costs, as well as important improvements in the manufacture of paper.

A RESEARCH program was undertaken to study the distribution of fibers on a fourdrinier wire and the resulting flow of water through these fibers as they built up on the wire.

Fig. 1. Conventional twill

The objective of the program was to improve the surface characteristics of the sheet, as well as its physical properties. In particular, a sheet less directional in its makeup was sought.

The conventional fourdrinier wire, illustrated in Fig. 1, has certain basic construction features which control the water removal flow and thus influence the distribution of the initial fibers to be deposited on the wire.

In Fig. 1 a warp wire is shown in profile. The shute wires seen in circular end view are generally below the surface of the warp knuckles, although in wires woven to produce fine grades of paper an effort is made in the weaving to raise the shute knuckle to approximately the same level as the warp knuckles. This can be effected by combinations of physical dimensions and chemical and metallurgical specifications of both the warp and shute wires.

The weave itself, commonly spoken of as "semi-twill," is a three-shaft uneven twill. One of its basic characteristics are sharp warp knuckles on the papermaking side of the wire on a diagonal pattern. This leaves the well-known wire mark as the fibers tend to bundle and align themselves in the direction of flow in the natural valleys of the mesh itself.

It was reasoned that if the weave of the fourdrinier could be altered so that the fibers descending in a random distribution could be held in that position as they contacted and built up on the surface of the wire, then the surface of the resulting sheet must of necessity be more level and uniform. Also, the physical characteristics of the sheet would then be less directional.

If the initial retention of fibers on the fourdrinier wire are in random orientation, it was reasoned that they would materially aid in the retention of fines and fillers as they were further deposited on the wire.

To accomplish this the fourdrinier wire must have equal support for the descending fibers in both machine and cross-machine direction. Also, it was recognized the flow characteristics were very critical. Water removal, it seemed, should be predominantly vertical in order not to disturb the random distribution of the descending fibers.

To produce a weave of these characteristics, an entirely new approach to weaving had to be made. The new weave was to be a four-shaft even twill, often spoken of as a "full twill." Figure 2 illustrates this weave. The physical specifications, both dimensional and metallurgical, had to be altered. Methods of weaving had to be changed and looms radically altered to produce this new full twill weave to the exacting specifications determined necessary in our research.

Fig. 2. New full twill

This part of the research seemed to satisfy our original objective so far as an improved media for forming a sheet of paper. There now seemed to be available an equally important gain to be made in the fourdrinier wire. If this same desirable top surface could be duplicated on the bottom side, then several important improvements were likely to be made. The increased surface would resist wear. Warp wires of this profile would resist fatigue. Less edge cracking could be expected. Power requirements would be reduced through less friction.

In conclusion, we can report that field tests thus far have confirmed the following:

1. The level surface on the top side of the wire produces more uniform finishes.
2. Formation is improved.
3. Fiber and filler retention is materially increased.
4. Drainage has increased.
5. Cross-machine strength has been substantially increased in some instances.
6. These new wires will not score or freeze to the suction boxes.
7. They do not need to oscillate.
8. Power requirements are reduced.
9. Edge cracking has been greatly reduced, and eliminated in some instances.
10. The level surface on the bottom side of the wire substantially increases wire life.

JAMES E. WATSON, President and General Manager, Wisconsin Wire Works, Appleton, Wis.

RECEIVED Jan. 31, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20, 1961.

Fire Testing Procedures

R. H. NEISEL

Testing materials for building code requirements calls for fire tests adaptable to a variety of materials. Many of the standard tests must be run on large samples and are expensive. A knowledge of the characteristics of large and small-scale tests will permit preliminary evaluation of materials and reduce the amount of large-scale testing. This paper compares current fire-test methods and attempts to show the similarities and differences that may be obtained in the test results.

FIRE tests have been devised for a variety of materials and purposes. A simple match test will classify many materials. For example, plain and flameproofed paper or regular and selfextinguishing grades of plastics may be roughly classified by that means. A more sophisticated test is required to measure the degree of flammability. The TAPPI Standard (*1*), "Flammability of Paper," for instance, ranks flameproofed papers in order of merit. There are many tests like this that rank certain materials well but are not adaptable to other materials.

Building codes must specify flame-resistant properties of materials for acceptability under various circumstances of use. For that purpose, tests are necessary that are applicable to a variety of materials. Such tests should, as far as possible, duplicate installed conditions and expected exposures. This requirement, of course, is difficult to attain at reasonable cost.

Fire tests as applied to building materials may be divided into three categories: (1) surface spread of flame tests, (2) combustibility tests, and (3) fire endurance tests.

FLAMESPREAD TESTS

There are several methods of testing surface spread of flame, but at present only two are generally included in building codes. The first is the fire test of the Federal Specification on Acoustical Units (*2*). This has been extended by several building codes to include all materials for interior wall or ceiling finish. The method was originally designed as a measure of combustibility.

This test subjects a 3 by 3-ft. specimen, supported with the face downward in a horizontal position, to a gas flame impinging at the center. The flame temperature is controlled to the standard fire curve, which reaches 1000°F. at 5 min., 1300°F. at 10 min., 1462°F. at 20 min., and 1613°F. at 40 min. Test duration is either 20 or 40 min., depending on the classification, with noncombustible materials requiring the longer exposure. Visual observation of the occurrence of flame from the sample, the duration, and spread of the flame, is required for rating. This test divides materials into four classes:

Class A—Incombustible—no flaming from sample.
Class B—Fire retardant—limited flaming of less than 10 seconds' duration.
Class C—Slow burning—flame will not spread to the supporting frame.
Class D—Combustible—flame will spread to the supporting frame.

As described, this test gives broad classifications but will show only major differences between materials. Figure 1 presents a view of a sample under test.

The second method cited in building codes is the Underwriters' Laboratories tunnel test (*3*). Test samples 25 ft. long and 20 in. wide are placed face downward on top of a troughlike tunnel and exposed at one end to a gas flame of controlled B.t.u. input and length. Air velocity is controlled,

R. H. NEISEL, Section Chief, Materials Evaluation Section, Johns-Manville Products Corp., Research Center, Manville, N. J.

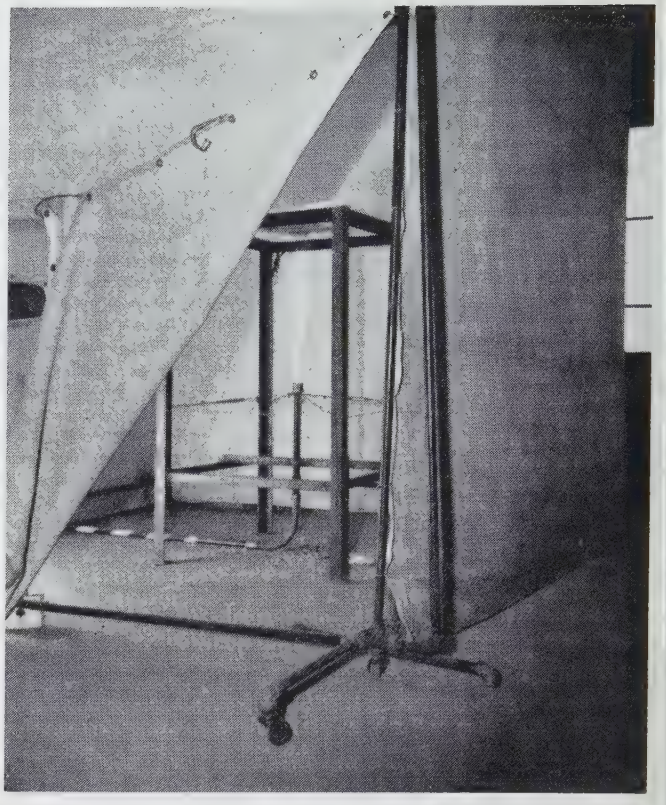


Fig. 1. Federal Specification SS-A-118b apparatus

and the progress of the flame front is observed through view ports. This test assigns numerical ratings of "flamespread," "fuel contributed," and "smoke developed" in comparison to red oak. Thus, a completely noncombustible material such as asbestos-cement board will be rated zero for all three items, while red oak will be rated 100 for all three items. Other materials may be assigned ratings from zero to 500 for flamespread. This test will assign continuous ratings but,

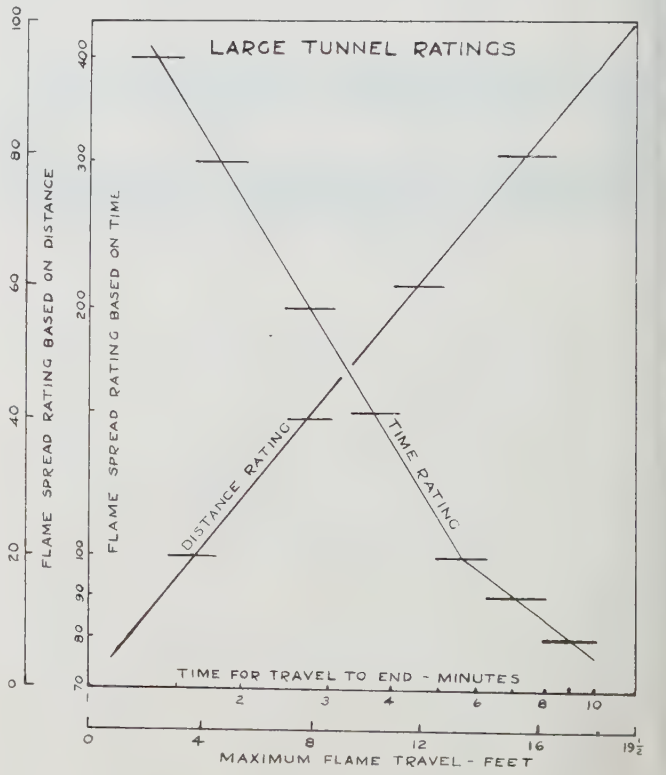

LARGE TUNNEL RATINGS
FLAME SPREAD RATING BASED ON DISTANCE
FLAME SPREAD RATING BASED ON TIME
DISTANCE RATING
TIME RATING
TIME FOR TRAVEL TO END - MINUTES
MAXIMUM FLAME TRAVEL - FEET

Fig. 2. Graphical presentation of large tunnel flame-spread ratings

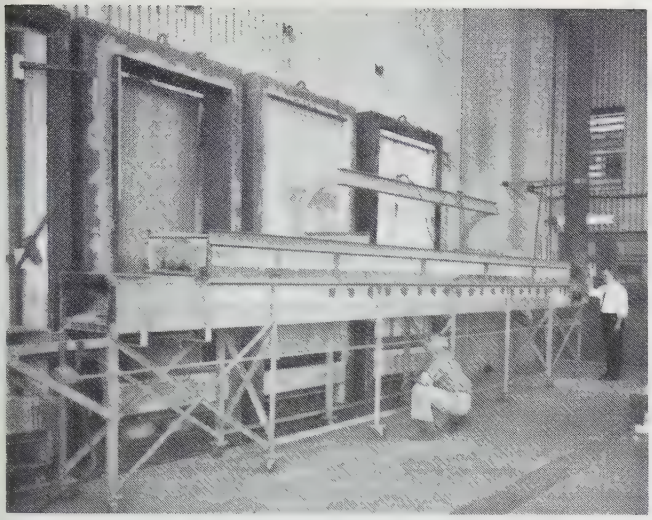


Fig. 3. Large flamespread tunnel

owing to the changing methods of rating, the scale is not linear.

Flamespread ratings are assigned on two bases: distance of spread for those that do not burn to the end of the tunnel, and time of spread for those that do burn to the end of the tunnel. Ratings so achieved would be as follows:

Distance of flamespread, ft.	*Time for 19½ ft. spread, min.*	*Rating, based on*	
		Distance	*Time*
5	...	26	...
10	...	51	...
15	...	77	...
19½	...	100	...
19½	10	100	77½
19½	9½	...	79
19½	8	...	84
19½	5½	100	100
19½	2¾	...	200
19½	1⅜	...	400

Note in Fig. 2 that ratings assigned on a basis of distance are linear while those assigned on a basis of time are exponential. Also note the difference between the slopes of the curves for materials on which flame travels faster than on wood (more flammable) and those whose time of travel is slower than on wood. This change in slope seems designed to insure that materials that burn to the end of the tunnel will always have a flamespread rating greater than 75.

Observers must witness and record the advance of the flame front. Agreement between observers and interpretation of what constitutes the flame front—the most advanced flame tips or some percentage of complete surface coverage—is difficult and requires experience. Measurement of smoke density is also difficult.

Figure 3 shows a large tunnel as constructed at the Johns-Manville Research Center. The vision panels are located at the bottom of the tunnel instead of at the side, permitting easier observation of the entire width of the sample and reducing deposition of combustion products on the glass.

As the large tunnel test is expensive, efforts have been made to develop less costly methods. One such method is the radiant panel test (*4*) developed by the National Bureau of Standards. This test uses an 18 by 6-in. sample. Only "flamespread index" and "smoke deposited" are measured.

The flamespread index is calculated as a function of the flamespread factor(Fs), which is computed from the times recorded for flame travel in 3-in. increments, and the heat evolution factor (Q), which is determined from the observed temperature rise in the stack. As the flame travel is downhill the flames from the sample do not preheat the material, hence the Q factor to compensate in the flamespread index.

The flamespread scale is similar to that of the large tunnel. This test is not expensive to run and accurate observation of the flame front is possible. Measurement of smoke density is, however, difficult to achieve. The even heat flux is believed to at times cause low readings for paint films or metallic foils over combustible basis. Under the uneven heat exposure of the large tunnel test such materials tend to crack and to emit combustible gases that contribute to flamespread; such cracking does not usually occur with the radiant panel.

Figure 4 shows a radiant panel apparatus, while Fig. 5 shows a test in progress.

The Forest Products Laboratory has developed a small tunnel (*5*) that tests samples approximately 14 in. by 8 ft. The lengthwise slope of the furnace is 6° from the horizontal so that only natural draft is required in performing the test. The sample is set with the short dimension at 30° to a horizontal steel plate which is heated by means of a gas burner at one end. The sample is exposed to thermal radiation from the plate and progress of the flame front is observed. As the flame front is steady and does not flicker, this is not difficult.

The calibration materials for this tunnel are red oak and ¼-in. asbestos millboard, and the index scales are 100 and zero as in the large tunnel.

Ratings are based on time of flame travel or distance of flame travel. The test period is taken as the time for flame on red oak to travel 87 in., or an average of 18.4 min. Ratings are calculated as follows:

1. For flamespread faster than on red oak

$$I_s = \frac{T_o}{T_s} \times 100$$

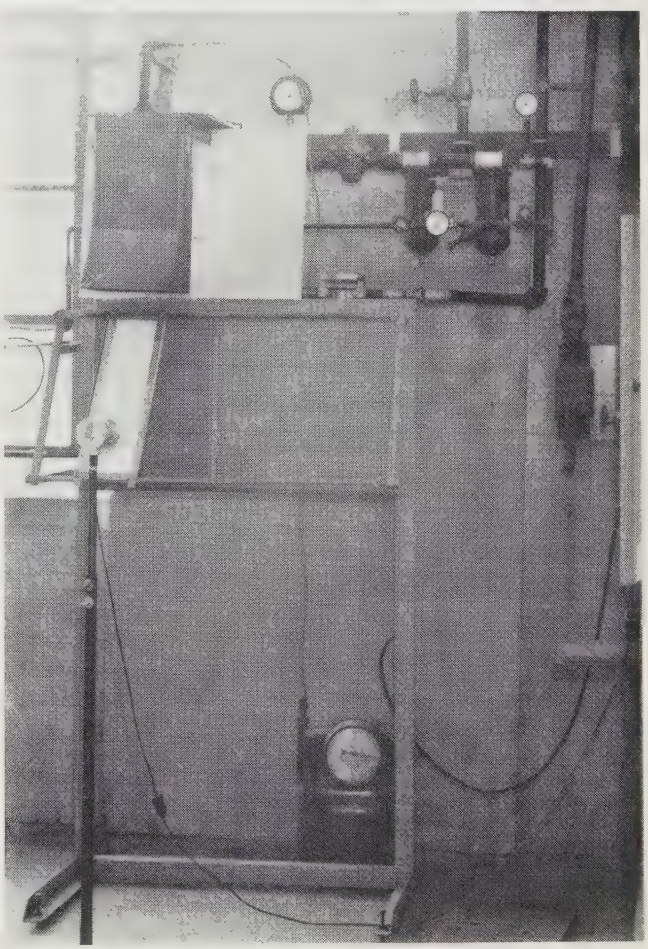


Fig. 4. Radiant panel apparatus

where

T_o = time to reach end of red oak
T_s = time to reach end of test specimen

2. For flamespread slower than on red oak

$$I_s = \frac{D_s}{D_o} \times 100$$

where

D_s = distance reached on test specimen in test period
D_o = distance reached on red oak in test period

From the above it may be seen that both scales are linear.

The article describing this test also shows correlation between the tunnel results and results obtained from corner fire tests in a room. The writer has not seen such published correlations for the other test methods.

Some correlation work has been done among the various test methods. Overall agreement is reasonable but some materials will achieve considerably different ratings from the various test methods. It is believed the following flamespread ratings were obtained on material taken from the same lots.

Material	*Radiant panel— NBS (6)*	*Large tunnel— UL (6)*	*SS-A-118b NBS (6)*	*Small tunnel— FPL (5)*
Fiberboard A	278	285	..	158
Hardboard M	121	113	D	94
Fiberboard C	94	77[a]	D	140
Gypsum board G	14	10	C	18
Fiberboard I (F.R. finish)	5	14	D	..

[a] It is believed this rating might increase to 89 under the criteria used at present.

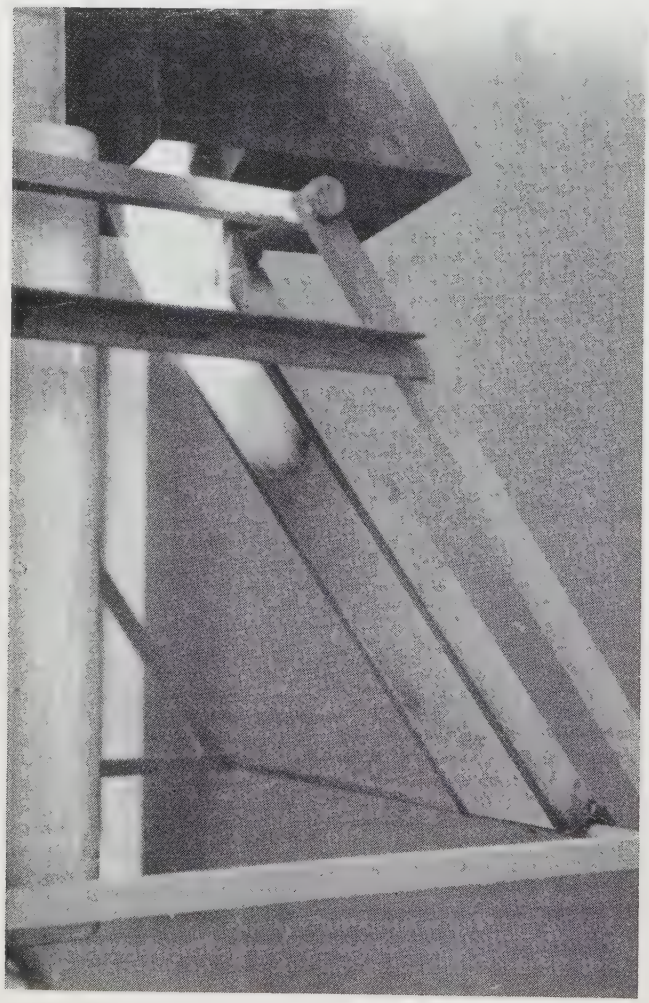


Fig. 5. Radiant panel test of combustible material

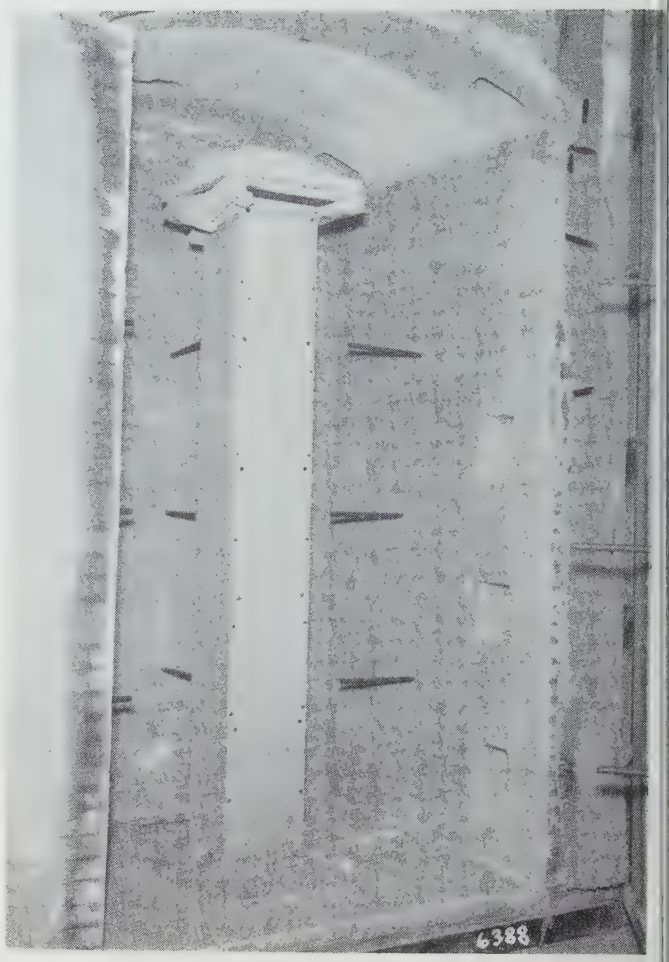


Fig. 6. Column fire test furnace

Additional correlation work is proposed under the sponsorship of the Insulating Board Institute, the Acoustical Materials Association, and the American Society for Testing Materials. An attempt to correlate full-scale exposures with flamespread ratings is also under way.

An excellent résumé of surface flammability test methods was recently presented before ASTM (*7*) by J. A. Wilson and may be referred to for a wider survey of such methods.

COMBUSTIBILITY TESTS

Combustibility tests specified in building codes are of three types: furnace exposure tests, the Federal Specification SS-A-118b test, and rating on the basis of the tunnel test.

Typically, the furnace tests require exposure at 1200°F. for 5 min. without ignition. Ignition is usually determined visually. A refinement of the method is described in the ASTM "Method of Test for Determining Noncombustibility of Elementary Materials" (*8*). It requires exposure of a sample at 1382°F. (750°C.) and limits temperature rise at the center of the sample to 54°F. (30°C.) above the initial furnace temperature. Flaming is permitted only during the first 30 sec. of exposure.

Classification by tunnel test flamespread ratings is determined by setting limitations similar to those presented in the Basic Building Code (*9*).

Federal specification class	*Maximum flamespread rating*
A—Noncombustible	25
B—Fire retardant	50
C—Slow burning	75
D—Combustible	200

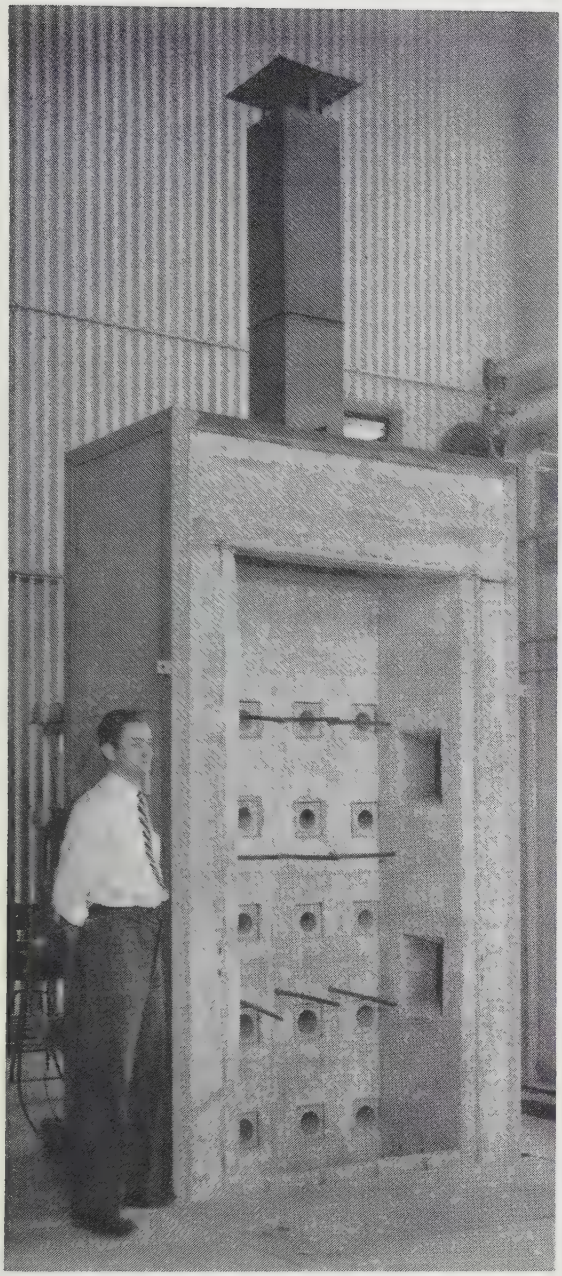


Fig. 7. Wall test furnace

FIRE ENDURANCE TESTS

Fire endurance tests are used to set time limits during which a wall, partition, floor, or ceiling will contain a fire and will not: (1) exceed a temperature rise of 250°F. on the unexposed face, (2) lose structural integrity, and (3) allow passage of gases hot enough to ignite cotton waste. The reasoning behind these requirements is to insure a barrier against the passage of flames and to limit the cold surface to temperatures below those at which organic materials will ignite.

Standard tests are commonly run in gas-fired furnaces and require sample areas of at least 100 sq. ft. for walls or partitions and 180 sq. ft. for floors or ceilings. The test methods are described in an ASTM Standard (*10*), "Fire Tests of Building Construction and Materials."

Furnace temperatures are controlled to the standard fire curve and reach 1700°F. at 1 hr., 1850°F. at 2 hr., 1925°F. at 3 hr., and 2000°F. at 4 hr. Furnace temperatures are controlled by means of shielded thermocouples, and unexposed surface temperatures are measured by thermocouples placed under felted asbestos pads. The pads are used to

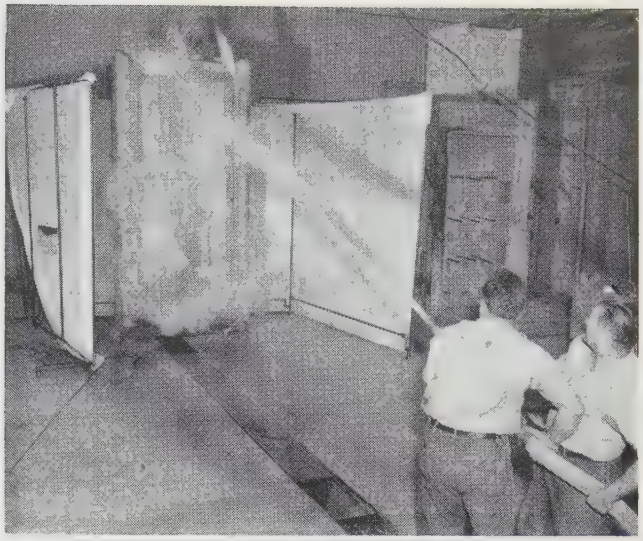


Fig. 8. Fire hose stream application

simulate the conditions existing when building contents touch the structural unit and cause higher temperatures than would exist without that contact.

Wall tests are run under load or unloaded, as required. Floor, beam, and column tests are usually run under design loads, with the requirement that the structures support those loads during exposure, although alternate methods allow unloaded tests through use of a temperature end point of 1000°F. for steel structural members. Such tests give ratings considerably shorter than tests conducted under load, since the temperature and point selected is conservative. Figure 6 shows a protected column following a 2-hr. fire exposure without load application. Note that flame surrounds the test column in this test. The protection for the top of the column had fallen during the cooling period following exposure.

Hose stream exposures are commonly made after the various fire tests to measure the integrity of the structure and its ability to protect against a resurgence of a fire following attempts at extinguishment.

Figure 7 shows a view of a furnace designed to accept 4 by 8-ft. panels. This furnace is large enough to comply with ASTM fire door test requirements (*11*), but is not large enough to comply with wall requirements. Figure 8 shows a hose stream application following a fire test. Note that the frame holding the sample has been removed from the test furnace in the background and that the stream is directed against the hot face. Figure 9 shows an interior view of a floor and ceiling furnace designed to accept 4 by 8-ft. samples.

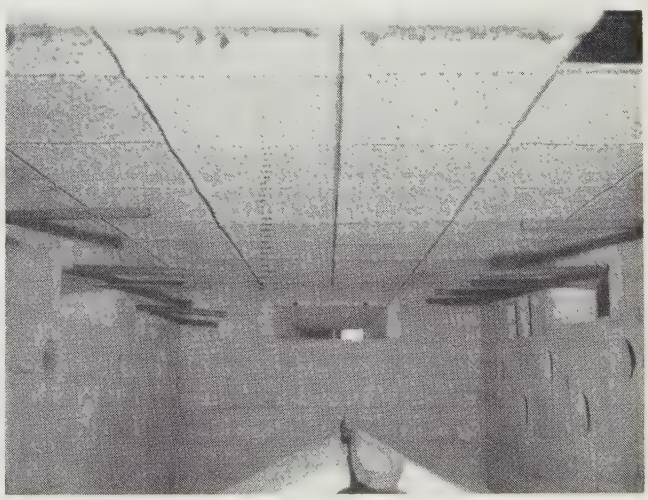


Fig. 9. Floor and ceiling furnace

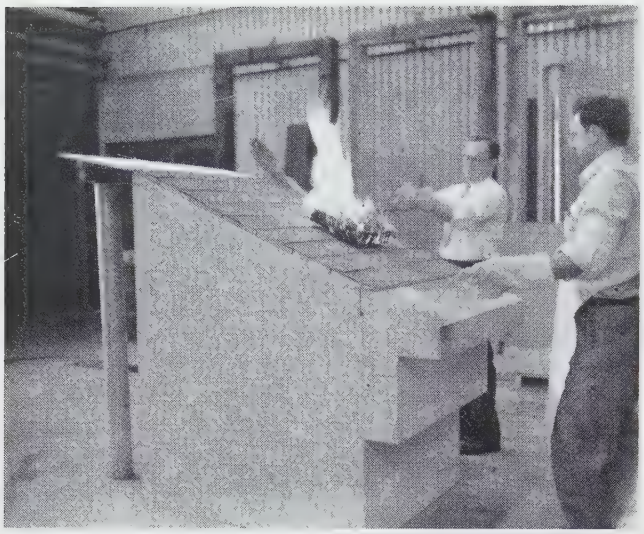


Fig. 10. Burning brand test on roofing

The test construction shown has been exposed to a 2-hr. fire test. This furnace also is too small to comply with standard size requirements.

Accurate estimates of temperature-rise ratings for walls or floors can be obtained from small furnaces, even as small as 2 by 2 ft., depending on sample thickness. Correlation of such results with large furnace results has been found adequate (*12, 13*). The small furnaces cannot, however, give complete information on structural integrity requirements. Column tests by the temperature-rise method can be run on columns as short as 3 ft., but loaded tests would not be comparable. Beam tests are difficult to run on a small scale, although temperatures may be obtained which are comparable to those attained in large-scale tests.

Combustible materials are not commonly used in fire walls, yet they can afford considerable protection. Tests have been run on sandwich panels of equal thickness with noncombustible covers, but with combustible and noncombustible cores. At $1^1/_2$-in. thickness, identical ratings of 47 min. were obtained. The interior temperatures of the combustible core were found to run considerably higher.

The higher specific heat, greater weight, and consequent higher heat capacity of the combustible core offset the noncombustibility of the second panel. Thermal conductivities of the two cores at room temperature are approximately equal.

FIRE TESTS OF ROOF COVERINGS

The other major fire test method cited in building codes is that for roof coverings (*14*). This includes tests for spread of flame over the roof surface and for ignition of the supporting roof deck by repeated flame exposure or lodgement of burning brands on the deck. In the latter two tests, the insulation afforded by the covering and the combustibility of the roof deck are of major importance.

Figure 10 shows placement of a class A brand on a test deck. The 2000-g. wooden brand is allowed to burn out on the deck surface while exposed to a 12-m.p.h. wind. Products are rated acceptable only if ignition of the roof deck does not occur during or following burn-out of the brand.

CONCLUSIONS

This description and comparison of test methods has been brief, but it is hoped that it may be helpful in selecting the material properties required in various products. The large-scale tests are expensive but with knowledge of the characteristics of the various tests one can use small-scale tests to select the most promising candidates for large-scale tests.

LITERATURE CITED

1. TAPPI Standard T 461 m-48.
2. Federal Specification SS-A-118b, Aug. 4, 1954.
3. U.L. 723, "Test Method for Fire Hazard Classification of Building Materials," Third Edition, August 1960, or ASTM E 84–60 T, "Method of Test for Surface Burning Characteristics of Building Materials."
4. Interim Federal Standard No. 00136, "Flamespread Properties of Materials." ASTM E 162–60 T, "Surface Flammability of Materials Using a Radiant Heat Energy Source."
5. Bruce, H. D. and Miniutti, V. P., *ASTM Bull.* pp. 61–68 (May, 1958).
6. Robertson, A. F., Gross, D., and Loftus, J., *ASTM Proceedings* 56: 1437–1453.
7. Wilson, J. A., "Surface Flammability of Materials, a Survey of Test Methods and Comparison of Results," presented during ASTM Committee Week, Feb. 1, 1961.
8. ASTM E 136–59 T.
9. Building Officials Conference of America, Inc., "Basic Building Code," 1955 Edition, Section 904.
10. ASTM E 119–58, "Methods of Fire Tests of Building Construction and Materials."
11. ASTM E 152–58, "Method of Fire Tests of Door Assemblies."
12. Neisel, R. H., *ASTM Bull.* pp. 66–70 (July, 1959).
13. Foster, H. D., *ASTM Bull.* pp. 66–67 (Feb., 1958).
14. ASTM E 108–58, "Methods of Fire Tests of Roof Coverings."

Received Jan. 19, 1961. Presented at 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y. Feb. 20–23, 1961.

Box Shop Quality Control

ROBERT J. HARLOW

This paper describes a box-shop quality control system that has been successful in spite of Murphy's Law. It explains the organization, methods of inspection and reporting. The statistical quality control method was discarded in favor of direct reporting of inspection results on a log-type chart. An inspection procedure wherein defects of each type are considered, coupled with the skill of the inspector, systematically ferrets out each and every defect. Paperboard has significant influence on carton quality. Uniformity of board is essential for quality and efficient production. Paperboard that is outside standard limits, as it affects production, can be used to produce quality cartons by making corrections in the box-shop providing the condition is known and is uniform.

Murphy's Law states that in spite of the best formulated plan, if there is a way of doing it wrong, someone will.

The purpose of this discussion is to describe how we have minimized the effects of Murphy's Law with box shop quality control and the benefits we have gained in the way of fewer customer complaints, less spoilage, and greater production. Our aim is to ship a product that will fully meet the customer's requirements and yield a profit to the plant.

Our box shop was established in 1950. The production workers were recruited locally. Many were upgraded at hiring. A typical situation requiring quality control!

Our quality control group is organized as follows. The supervisor replies directly to the plant manager. There is a total of five inspectors. We prefer female inspectors since they are more adept at performing the routine inspection procedure. There are two inspectors on the first shift and two on the second shift. On the third shift there is a lone male inspector. Our third shift operation is cut back about 50% from the first and second shift operations. The inspectors are salaried employees.

Robert J. Harlow, Quality Control Supervisor, Continental Can Co., Inc., Uncasville, Conn.

In our plant there are six letterpress printing presses. They range from a one-color Miehle on up to a four-color Miehle. There are two high-speed Harris rotary presses. Also, we have two Miehles converted to duplex presses.

In the cutting and crossing department there are six Miehle cutting presses and one Chancler job press.

In the finishing department we have three straight-line gluers, two right-angle gluers, two Staudés, and a window applicator.

The volume is in excess of 1000 tons per month.

Our concept for quality control places the responsibility for quality work on the production people. That concept is paraphrased in the expression "Quality cannot be inspected into the job, it must be built into it." Only when the departmental foreman has checked over the job and given his approval to run does quality control take up the inspection routine.

After two years we discarded the statistical quality control technique. We thought it more realistic to have our inspectors looking at the product than preparing charts and graphs. Now we use straight reporting on a log-type chart. If the inspector finds the job is okay, that is what she reports. If there are defects of a minor nature, they are noted, but not as a defective quality condition. A major defect is underlined on the chart and reported as a "yellow condition." A critical defect is underlined on the chart and given a "red condition." A metal box with two lights, red and yellow, and a control switch is mounted on each piece of equipment at a height that gives it an unobstructed view from any place in the room. When the inspector reports a red or yellow condition on the chart, she turns on the appropriate signal light. This tells the operator and the foreman that there is an off-quality condition. It is quick and effective in bringing about corrective action. Meanwhile, the inspector is on to the next job.

A major defect is something that requires correction at the first available opportunity. A critical defect is one that must be corrected at once. Usually a critical defect is not shippable. To prevent further work being done on the carton blank with a critical defect and to separate it so that it will not be shipped to the customer we employ large bright-colored "hold" tags. "Hold" tags are placed on the load with instructions for disposal of the defective material. They ride with the defective material until it is separated from the good material. We insist on a strict accounting for all "hold" tags.

The quality control personnel cannot shut down an operation. They should request such action if the condition warrants. This is consistent with holding production responsible for the amount of off-quality production.

The quality supervisor is a staff member and has no line authority. When a controversial quality condition exists that the quality supervisor and box shop superintendent cannot resolve, the matter is carried to the plant manager. The present manager gives quality control 100% backing. This support has strengthened my position so that now we seldom reach an impassés. As the program developed, the supervisor became able to pass judgment on individual cases on their merit. This places the burden for quality decisions on the quality supervisor, as it should.

Two weeks is the minimum time spent teaching new inspectors. Following the training period they are allowed to perform the inspections on their own, but with continued close supervision. It takes about three months for the average woman, with no previous experience, to become a proficient and reliable inspector. Inspectors always work the same shift. They rotate between departments every two weeks. The production crews rotate shifts each month.

Murphy's Law applies to all people in a manufacturing plant, inspectors included. When an inspector obeys Murphy's Law, expensive spoilage is exceeded only by the embarrassment of the quality control group.

Here is the inspection procedure. In printing, the foreman checks the job before giving final approval to run. He checks the running color against the approved color. It is his duty to give the inspector a swatch of the wet inks when the job is approved for running. This is the inspector's signal that the job is ready.

The inspection procedure in printing is as follows: (1) read the order, (2) check the colors against the standard, (3) inspect the sheet for: (a) color, (b) register, (c) dirt, (d) batters, (e) streaks, and (f) impression.

The inspector rechecks the swatch against the approved color and allows the ink to level off for 10 minutes. Then she establishes a standard reading of the wet ink using the Densichron. With this instrument we are able to get numerical values of color density. With a standard gray chip as reference we are able to get uniformity across the sheet and throughout the run. The first inspection is exhaustive. In addition to reading all the order, the copy is rechecked by the inspector. On some layouts, the copy is different for each carton blank. This makes the inspection time consuming but worth while.

The register is checked between colors and for cutting register using an oil sheet or the "strike-in" method.

The lay-out is checked against the order to see if the correct number of specified blanks are on the sheet. When the job is started right, the remaining inspections are to see that the quality level is maintained. It becomes a routine check.

The inspection procedure in cutting and creasing begins after the foreman has checked out the job and notified the inspector that the job is approved for running. It is as follows: (1) read the order, (2) check the samples against the layout, (3) inspect the sheet for: (a) cutting, (b) carton dimensions, (c) creasing, (d) line-up, (e) register between cutting and printing, (f) nicks, and (g) missing knives.

As in printing, there is a step-by-step inspection procedure for cutting and creasing that will shake out the defects. We check the edge trim for ease of stripping. The cutting is checked for cleanliness and completeness.

Carton dimensions are easily checked from the given dimensions or the blueprint when supplied. Once the dimensions are checked for one carton, the remaining identical cartons can be quickly checked by comparing them with the measured carton.

Creasing is checked by giving each crease and score a full 180° bend.

Line-up means the first and fourth panel must be parallel where they meet at the glue line. On jobs for the right-angle gluer, the inspector has the gluing foreman recheck the line-up for machine characteristics.

The register is checked to determine if the printing copy is properly aligned on the cut and creased panels. Nicks must be used to hold the cut sheet together for delivery. Too many nicks and big nicks give an unsightly appearance. They also make stripping difficult. Too few nicks allow the sheet to break up in the press delivery. Knives have a tendency to pull out or break off.

In the finishing operation the inspection procedure is also spelled out. There are conditions in finishing that differentiate the quality control procedure from the pressroom procedure, namely; (1) this is the final inspection before the customer sees the cartons, (2) all of the cartons coming off the gluer are supposedly identical, (3) the cartons must be packed so they will arrive without damage, (4) they must be counted accurately to conform to the count on the label, (5) the labels must be accurate.

To make the finishing department inspection we check as follows: (1) read the order, (2) check label for: (a) item being cased, (b) customer's name and address, (c) plant production order number, (d) quantity packed. (3) Inspect at machine for: (a) gluing, (b) line-up, (c) creases, (d) final makeup, (e) color uniformity, (f) ink rub, (g) count, (h) packing, and (i) mixed items.

At the gluers we inspect for too much, too little, or dried glue.

The cartons must line up physically as well as giving good printing wrap-around. Creases must fold clean and sharp. Rolled or extra creases are not tolerated. The odd-numbered scores must be prebroken. The outer liner should not crack.

In the final makup, the cartons must make up square and tight.

Sometimes ink will rub due to heat and friction from the guide rails rubbing on the printed surfaces.

Count is important and is part of a two-way street. We must ship the customer the quantity we bill for and stand to lose if we pack more than that for which we bill.

Finally, the cartons must be packed so they all arrive in good condition.

We hold a brief meeting each morning to discuss the previous day's board production. At the same time we discuss any problems on the orders being run.

Uniformity of board is the watch-word for quality carton production. For if there is a known substandard condition, it may usually be compensated for and processed normally. Board that does not meet customer standards is not accepted.

A person might think that there should be no problem to maintain color once the fountains are adjusted for ink flow. Such is not the case. The board varies in penetration both along as well as across the machine. To overcome across-machine variation in board finish, we ask the manufacturer to pile the sheets from each machine position, front, middle and back, on separate skids.

We can tolerate a slight amount of rupture on unprinted creases. When the creases have been printed, then rupture ruins the appearance and cannot be tolerated. We have been using the BRDA creasability tester to some degree of success. Results of incoming board tests are sent to the cutting and creasing foreman who takes precautionary measures in the makeready to overcome the board deficiency. It may well be that with standardization of methods and materials in the folding carton trade, that board will be standardized, giving us fewer grades, and hence fewer board problems to cope with. The degree to which a job can go awry may be limited. Usually there is a clue that something is wrong. It's up to the foremen, supervisory, quality control, and production personnel to recognize and act on them. For instance, with 5 in. of trim on the back edge of a sheet, the operator thought something was not as it should be. Checks with the order and samples showed nothing wrong. A night call to the planner brought the instructions, "Everything is all right." "Go ahead and run." But the next day, after checking further, it was found that the approved sample cartons with the order were not the ones that were to be run on that sheet.

It is because of Murphy's Law that there is a need for quality control inspection. The inspection should follow a routine procedure so that it will filter out just about any defect that occurs. I have been fortunate for the most part in having inspectors who have been alert to the routine defects and recognize the clues. In addition, I have had strong management support.

For a number of years we have publicized the spoilage reports monthly. We also use a sheet originating in the first operation to show the number of sheets converted. This sheet is passed along to each operation showing the press and packed count. In addition to keeping the subject of spoilage always in the minds of the foremen, it has other benefits, such as bringing the entire job together at one time.

SUMMARY

That is a description of our box shop quality control. We have a record of which we are justifiably proud. Here are the hard cash results:

1. Dollar value of customer complaints has been reduced from a high of $12,000.00 in 1957 to a record low of $3,000.00 in 1959.

2. Our in-plant spoilage has been reduced each year by about 3% below the preceding year. This decrease is worth about $20,000.00 annually. Our annual average in-plant spoilage is in the vicinity of 2.5%, well below the national average.

3. Our production has increased each year about 3%.

4. Strong management and production support is necessary for effective quality control. It takes deeds, not lip-service to show management backing.

5. Quality control is basically human relations, "90% know-who and 10% know-how." To show our workers our appreciation for their effort in this achievement we place congratulatory posters and letters on the bulletin boards.

Murphy's Law is still a continuing force but its effect is being felt less and less.

The results of good quality control are: (1) better quality, (2) fewer customer complaints, (3) increased production, and (4) reduced spoilage.

Received Jan. 18, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York N. Y., Feb. 20–23, 1961.

Microcomponents, Their Effect on Mass Appearance

Practical Application of Microscopy in the Graphic Arts

ERNEST SCHMATOLLA

This paper deals with the study of micro components in the graphic arts, with emphasis on letterpress, photoengravings, electros, and presswork results. The work was mostly done on the production level and developed through trouble shooting, production problems and material inspections. During the course of this work an inspection scope was developed, specifically built to fit the needs of the craftsman; the observations can be documented by Polaroid photomicrographs.

The use of microscopy in the graphic arts covers many years. Its first principle application was in the papermaking industry. All pulp and paper mills have control and research laboratories and depend to a great extent on the findings of the microscope. Large ink manufacturers also have installed such laboratories and are at present making use of every type of microscopy. Yet at the level of the production of the printed matter nothing much to speak of has been achieved. Printing plants operate strictly on craft skills, accepting all kinds of materials, combining and processing them based on previously collected and reported experiences. This can be considered as quite an achievement in a craft which at present is rapidly changing processing methods and materials, constantly challenging the resourcefulness of the craftsman with his empirical methods. In this area the application of scientific controls would without a doubt reduce the craftsman's problems, increase production and raise the quality of the work.

Between thirty and forty years ago, letterpress or relief printing was the predominant process with offset lithography as a mediocre substitute affording economies. However, it was recognized at once that this process had many advantages from the standpoint of press production at higher speeds, simplicity of assembling the image carrier, and the ability to print on many kinds of paper but requiring greater uniformity of results and better quality. To achieve these improvements much closer processing tolerances had to be obtained and maintained in all branches, photography, chemistry, physics, mechanical settings, and materials. The litho industry recognizing this then established The Lithographic Technical Foundation which, on the basis and with the aid

Ernest Schmatolla, Rogers Kellogg Corp., Long Island City, N. Y.

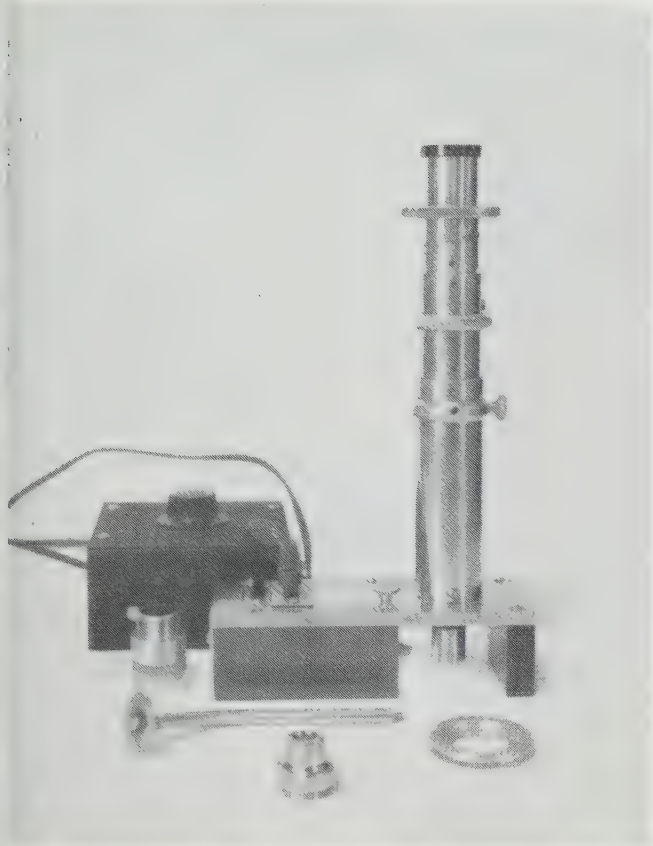


Fig. 1. The complete scope with attachments

of all types of research, disseminated technical information and trained personnel. The results of this effort speak for themselves.

GRAPHIC ARTS INSPECTION SCOPE

About thirty years ago, the author, a member of the New York Microscopical Society, envisioned the use of the microscope as a tool for trouble shooting and combined with photography as a means of documented settling of differences of opinion, a pictorical proof of a problem condition. From that time on many case histories were assembled, documented by black and white and full color photomicrographs and slides. With the passing of years and the rapid increase in labor and machine hour costs, not forgetting material costs, great emphasis must be put on careful preparation and critical inspection of materials going into the work. To accomplish this better, a prototype scope was designed four years ago and at present a number of production scopes are in daily use in plants. The scope (Fig. 1) purposely designed as a graphic arts tool uses standard microscopic optical equipment. It is constructed without the delicate fine adjustment gear, or other gears and pinions. It is adjusted by two spiral keyways and can be used by workmen without fear of damage. Depth measurements are made by changing the distance between ocular and the objective lenses (Fig. 2); it contains its own illumination with two small batteries as well as a 110-v. variable light control (Fig. 3); it stands firmly on the work and a Polaroid camera can be balanced on top to produce photomicrographs in less than 1 min. (Fig. 4). When measuring elements on photomicrographs the ratio is 64 to 1 (1 in. on photo equals $^1/_{64}$ in.) using the standard setup. Lenses can be changed to increase or decrease these measurements. Visual observation and photomicrographs can also be made at an angle of 45° (Fig. 5) showing top and sides of half-tone dots and photographed to document the depth of etching. This explanation of the equipment now brings us to the subject matter of the title of this paper.

Prior to the development of microbiology the treatment of diseases was based on observations of symptoms and recorded experiences of results, many times by trial and errors ending in successes and failures. The true cause of many diseases was then not known, due to the smallness of the microorganism. In printing, the final result depends on the mass appearance of millions of individual microcomponents, too small to be properly observed by the customary magnifying glasses. The far reaching effects of minute variations in these microcomponents, while being understood and dealt with in mass appearance, have not been sufficiently studied microscopically as individual components, with the exception of research workers. Fortunately, in the last decade the importance of the scientific approach has been recognized by the industry with the result that at present there are research organizations and technical societies whose projects and activities benefit the industry. However, to the rank and file production worker the word science is closely related to research which is to be left to the laboratory workers.

It is the object to stimulate craftsmen on the production level to learn to examine and interpret the appearance of the microcomponents. To recognize problems and prevent failures of quality or production efficiency. To keep this in the language of printing, using simple instruments.

The product of our industry, printing, consists of an image carrier (type or plates) repeatedly depositing printing ink on a surface (paper or board, etc.) The image carrier, if a 120 line halftone size 10 by 10 in. in one color, contains 1,440,000 microcomponents of various surface sizes and etched to various depths; if four color process, this number may go to five and one-half million.

Printing ink is a dispersion of pigment in vehicle. The size of a large pigment particle is 0.0001 which by proper mixing and grinding should be wetted by the vehicle. Paper, the surface upon which ink is transferred with pressure by the image carrier, consists of various types of fibers with or without mineral loading or coating. Its varying surface characteristics in smoothness and ink affinity provide the third component of the printed product. The complete compatibility of the image carrier, ink, and paper will

Fig. 2. Graduations for depth reading

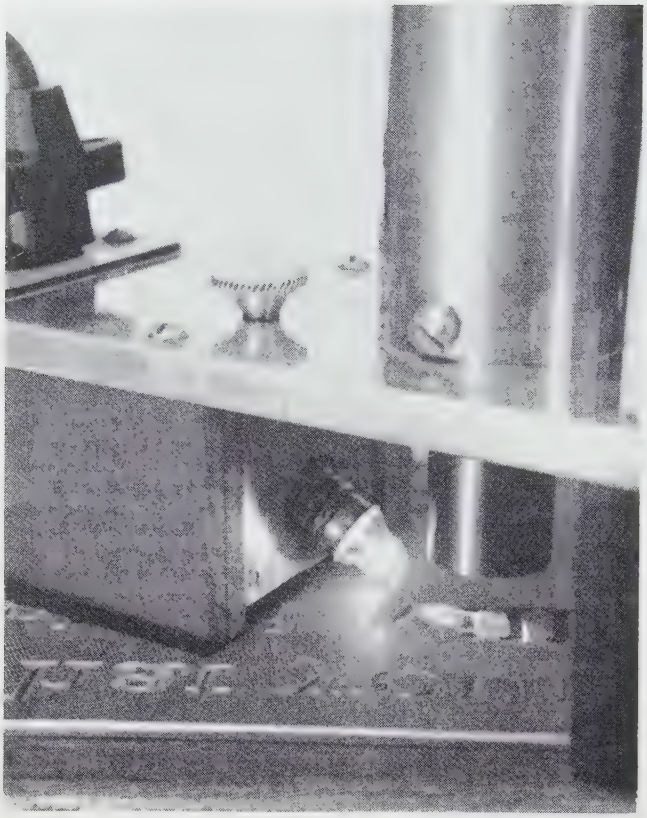


Fig. 3. Close-up showing illumination and control

produce a quality product if printed by competent craftsmen on suitable presses in perfect mechanical condition. To successfully implement a method of control by means of a scope the craftsman must train himself by observation and comparison. When viewing a 120-line halftone 100× one sees only about 25 halftone dots of the 14400 contained in

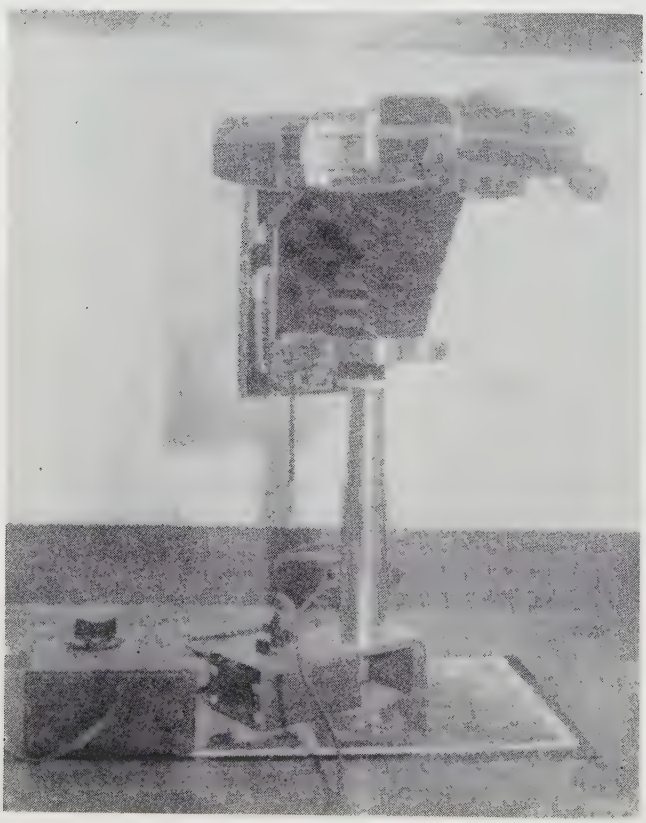


Fig. 4. Polaroid set-up

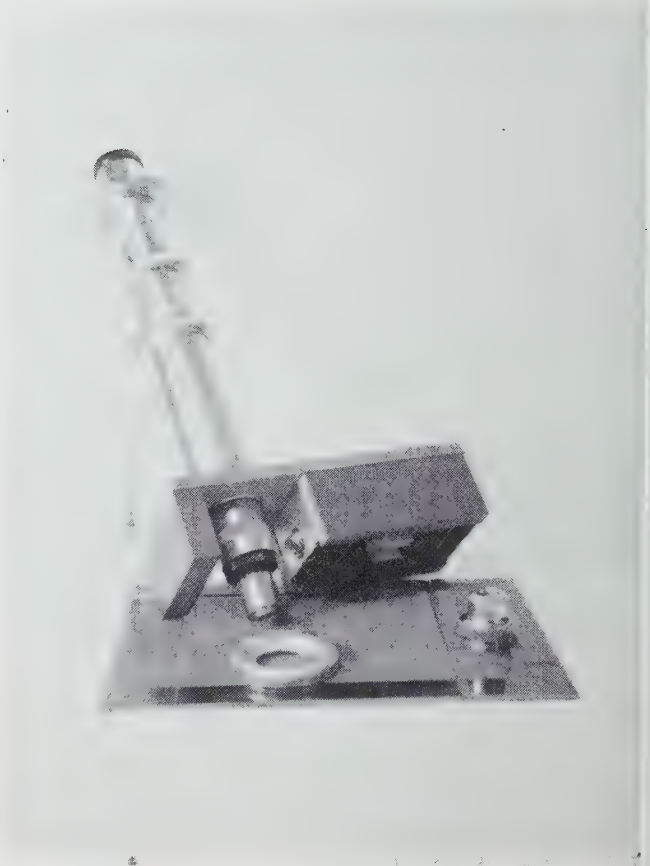


Fig. 5. Forty-five degree angle viewing

1 sq. in., it looks like another world, unfamiliar territory. The three dimensions up and down, top and bottom, right and left at first confuse the viewer. In a short time, with a little experience, an amazing amount of information can be obtained from each field of view. Like a physician making a diagnosis from a stained blood slide, a skilled technician can interpret plates or progressive proofs and report a series of facts relating to the work. For example, the following can be determined with one field of examination of a process color engraving or electrotype: (1) angle of screen, (2) screen lines per inch, (3) nature of top, (4) depth of etch, (5) and cleanliness of bottom, (6) presence or absence of undercut, (7) height of shoulders or connectors between dots, etc.

On examining the completed progressive proof of a four color subject: (1) angles of the four colors, (2) screen lines per inch of the four colors, (3) proofing was made dry—one color at a time, delayed, two colors wet followed by two other colors wet, or all four colors wet, (4) direction of proofing (this at times difficult), (5) ink trapping and (6) paper surfaces, etc.

To get the most benefit and obtain the best results from these methods all interpretations should be correlated with the practical experience and know-how of the craftsman. In new work, after correct planning, visual inspection usually starts with the original engravings and progressive proofs followed by running electros and paper. At times paper and ink compatibility tests are made when high standard of quality is required. In cases of trouble shooting, press sheets are used to determine mechanical press failures, make ready, ink trappings difficulties. Running plates are also examined when unusual wear occurs. An effective inspection system together with a few other simple practical tests can make substantial difference in quality and production efficiency.

Received Jan. 18, 1961. Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

Water Requirements and Treatment for High Pressure Boilers

HUGH E. CARR

Methods of controlling water conditions in high pressure boilers are recommended with emphasis on the prevention of iron and copper corrosion in condensate return systems. Filming amine is found to be an effective, economic solution to this problem, when care is taken in establishing feed rates and controlling total iron and copper returned to boilers.

For greater efficiency, the pulp and paper industry has been going to high pressure (900 to 1500 p.s.i.) steam generating plants. This is an obvious step in the modernization program aimed at reducing the cost of one of the basic utilities—electric power.

With a high-pressure boiler a topping turbine can be installed to generate kilowatts cheaper than they can be purchased or produced in older, less efficient condensing turbines. In a utility cycle, low-pressure steam is usually condensed which results in lost B.t.u.'s. In a paper mill this low-pressure steam can be extracted to supply mill demands—paper machines, driers, digesters, evaporators, heaters, etc.

Theoretically, the higher the steam temperature the more efficient the operation. However, there are limitations. As the temperature increases so does the cost, size, and complexity of the equipment. The most suitable operating methods for each mill should be selected on the basis of a comprehensive engineering survey, taking into account such things as projected power demands, amortization of equipment, forecasted production, etc.

Many of these new boilers can operate on available low-quality fuels such as bark, lignite, and spent liquor which were formerly considered suitable for use only in low-pressure boilers. It is not uncommon to replace six to eight old boilers with a single unit producing up to half a million pounds of steam an hour. Frequently high-pressure boilers can be installed in available space and tied in without changing basic production equipment.

CONTROLLING WATER CONDITIONS

At one time steam above 900 p.s.i. and 535°F. was restricted to utilities operating on a closed loop with a low percentage of makeup. It has been just within the past few years that the process industry has broadened into high-pressure applications. The transition was not easy. When utility-type boilers are operated under conditions encountered in paper mills, there are bound to be problems requiring specialized attention. Precise control over water conditions—makeup, feedwater, boiler water, and condensate—is essential. A sound program must be set up and followed if these newer units are to operate trouble-free for extended periods.

Since there are many places in a paper mill where there is direct steam consumption (digesters, bleachers, etc.), most boilers operate on 40 to 60% makeup. For this reason, as an integral part of the high-pressure installation, there usually is a deionizing plant. This supplies high-quality makeup for the boilers. A deionizing system replaces hot lime-soda softeners, zeolite exchangers, or just internal chemical conditioning which are acceptable pretreatment methods for low-pressure boilers. Many of the deionizers have fully automatic regeneration systems and alarms which warn operators when there is a malfunction. Most mills drawing from surface water supplies have found it necessary to clarify and decolorize water prior to deionization to prevent fouling of resin beds and to eliminate organic leakage into boilers. Coagulant aids and improved sterilization procedures have been helpful in many of these cases.

Routine analytical tests must be performed on samples of deionized water to be certain the required quality is maintained. A separate water laboratory and special analytical equipment (photometer, pH meter, etc.) should be provided for accurate analyses in the low concentrations involved. Well-trained personnel are essential. With the increased volume of testing required, many add another analyst to laboratory staffs.

The next step for proper water-side operation of a high-pressure boiler is chemical conditioning of the boiler water. Chemical control limits vary with equipment and operating pressures. Good internal water conditions are even more essential in high-pressure boilers than in low-pressure units. Scale formation, corrosion, embrittlement, and steam contamination positively must be prevented.

CONDENSATE SYSTEM

The most critical part of the steam-water cycle requiring attention is the condensate return system. It is necessary to limit pickup of corrosion products and contaminants. Generally, return systems are strung out over several thousand square yards, affording many chances for condensate contamination.

The installation of high-pressure boilers does not make condensate system corrosion any more severe. It does, however, necessitate keeping iron and copper in the feedwater at an absolute minimum. At low pressures, some accumulation of corrosion products can be tolerated in boilers without causing tube failures. A slight resistance to heat transfer is not so critical since the metal is not subjected to high temperatures for prolonged periods. Many mills use a condensate treatment in low-pressure steam systems, primarily to reduce extensive condensate piping maintenance or replacements, protect drier rolls or increase heat transfer in equipment rather than to control the pickup of corrosion products continually returned to boilers, although this certainly also follows. The problems are the same—only the point of emphasis has been changed.

TESTING PROGRAM

In mills anticipating high-pressure boiler installations, an immediate iron and copper testing program should be established. This is necessary to determine the degree of contamination. Samples should be obtained from the main mill condensate returns, as well as from boiler feedwater lines.

For reliable iron and copper data, sampling and testing procedures are extremely important. All sampling coils, lines, valves, and fittings should be stainless steel or Inconel. Sampling lines should be continuously flowing since the adjustment of a valve can dislodge enough oxide particles to give unrepresentative results. Equipment (glassware, sampling bottles, pipets) must be cleaned by allowing the apparatus to stand in specially prepared solutions. Methods are available for colorimetrically determining iron and copper concentrations with an accuracy of a few parts per billion (*1*).

Experience has shown that iron and copper concentrations fluctuate over a fairly wide range. Initially, and until experience warrants otherwise, daily sampling is necessary to give a complete picture. When condensate treatment is started, iron and copper values provide a guide for controlling the feed of corrosion inhibitors and determining their effectiveness.

CAUSES OF CONDENSATE CORROSION

A brief explanation of why iron and copper are present in the condensate is in order. Metals have a natural tendency to dissolve in water. As these metals go into solution, they react with water to form a protective oxide coating. This stops further corrosion or else equipment and piping would completely deteriorate. Any chemical or mechanical process

Hugh E. Carr, Chemical Products Engineer, Hagan Chemicals & Controls, Inc., Pittsburgh, Pa.

Fig. 1. Dense layer of magnetic iron oxide in a wall tube close to a boiler burner

This deposit acts as an insulating barrier and does not permit circulating boiler water to sufficiently cool the metal surface.

which breaks or removes the oxide coating causes corrosion to proceed.

Steam condensate, alone or combined with other waters, can cause corrosion. The presence of gases—oxygen, carbon dioxide, sulfur dioxide—make condensate even more corrosive. Of these gases, oxygen and carbon dioxide are the most common.

Carbon dioxide is introduced into steam by decomposition of bicarbonate or carbonate in the boiler water. It dissolves in condensate to form carbonic acid. This acid promotes corrosion by dissolving the protective oxide coating, producing a uniform etching or grooving type attack. Such attack is speeded up in stressed areas such as at threads on pipe nipples.

General pitting and tuberculation are indicative of dissolved oxygen corrosion. Oxygen can enter a system with the makeup or by inleakage of air into vacuum and gravity return systems, open lines, pump gland seals, loose joints, or open air vents. In a paper mill operation, there is considerable oxygen leakage into driers when they come off the line.

OXIDE DEPOSITS IN BOILERS

Thus, as condensate flows over confining surfaces, it continuously dissolves metals it contacts and carries with it corrosion products, primarily iron and copper. These can get into boilers with the feedwater unless there is a program to control and minimize corrosion. For example, 0.25 p.p.m. of iron in a condensate stream going to a boiler rated at 500,000 lb. per hr. and operating on 50% returns, means that 750 lb. of iron oxide (Fe_3O_4) can be carried into a boiler in a year.

If preboiler corrosion products always accumulated as sludges in the mud drum or were uniformly dispersed throughout the boiler, they could be removed periodically without causing any particular operating problems. Unfortunately, iron and copper compounds have a tendency to collect in localized areas at the worst possible places—wherever heat input is the greatest. This often occurs in wall tubes, around burners, or in the inclined portions of arch tubes which form the roof of the furnace (*2*).

Iron and copper oxides offer resistance to heat transfer. With high heat inputs, oxide scales act as insulating barriers and do not permit the circulating boiler water to sufficiently cool the metal surfaces. If the metal temperature reaches 900°F. or above, failure by overheating will result.

Table I. Average Iron and Copper in Main Mill Condensate Returns

Boiler pressure, p.s.i.	*Total Fe, p.p.m.*	*Total Cu, p.p.m.*
1450	0.14	0.03
1500	0.20	0.08
1250	0.40	....
900	0.26	0.04

Corrosion rates, mg./sq. dm./day[a]	
Before condensate treatment	*During hagafilm treatment*
300	10
29	2
80	0.8
53	1.6
105	1.2

[a] Determined using 2 by 1-in. mild cold-rolled steel corrosion test specimens.

Deposits of corrosion products in a boiler can be damaging in another way. Boiler water solids can concentrate beneath them because there is no rinsing of the metal surface by flowing boiler water. Extremely high concentrations of solids can cause attack of the tube surfaces under the scale. The result is the same—a failure at an area of high heat input.

The majority of the mill condensate piping is iron and carbon steel. However, appreciable amounts of copper can also be present as copper alloy tubes in feedwater heaters, process heat exchangers, evaporators, valves, and fittings. Typical values for iron and copper pickup in systems are shown in Table I.

An obvious question is: what should the iron and copper in the feedwater be in order to operate high-pressure boilers with a minimum of troubles? Until recently, stock answers have usually been "As little as possible" or "none." Boiler makers now talk in terms of a maximum figure of 20 p.p.b. combined iron and copper. Our own experience indicates that a maximum of 10 p.p.b. total iron and copper is none too low. These extremely low values are not easy to attain in industrial plants.

MINIMIZING CORROSION

Now comes the big question: What can we do about condensate system corrosion? One or both of two things: get rid of the corrosive gases in the condensate or use a corrosion inhibitor. Because dissolved gases are responsible for condensate corrosion, steps are automatically included in a high-pressure boiler plant to minimize them. The boiler feedwater

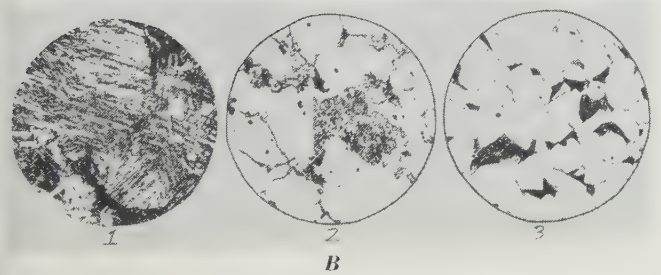
Fig. 2. Thinned tube section which has been acid pickled to remove the build-up of corrosion products

Note the attack of the tube surface under the deposit where boiler water solids concentrated and were not rinsed by flowing water.

is deaerated—normally in a heater guaranteed to reduce the dissolved oxygen to a maximum of 0.005 cc. per l. In a deionizing plant, bicarbonates and carbonates in makeup are removed by anion exchange or by decarbonation following cation exchange. For this reason, carbon dioxide in the steam should be low (less than 1 p.p.m.). However, it can be higher if low pressure boilers are in service also and there is a common steam distribution and return system. Even though boiler feedwater may be deaerated, significant amounts of oxygen may come in through leaks in the return systems, especially when paper machines are temporarily out of service. Further efforts to mechanically eliminate gas contamination may not be economically justified.

The second approach, an inhibitor treatment, represents the most direct and effective means of reducing condensate system corrosion. There are two types of corrosion inhibitors available: filming and neutralizing. Neutralizing types establish and maintain a protective film of oxide on the metal by controlling condensate pH. This is accomplished by their chemically reacting with carbon dioxide to neutralize acidity. These inhibitors include ammonia, morpholine, and cyclohexylamine.

A



B

Fig. 3. (A) Boiler tube failure caused by overheating

(A) Deposit of corrosion products formed on the fire side of the tube and the metal was heated to above 1330°F. Note when the tube failed and the boiler water escaped all the deposit was scoured from the area of the failure.

(B) Micrographs (500×) of metal removed from areas in failed tube—identified by nos. 1, 2, and 3 in the above. In no. 1, the structure is that of martensite produced when low carbon steel is heated above 1330°F. and suddenly quenched. In no. 2, the structure indicates a temperature of 1200°F. Here the dark colored carbide areas are in a sphericidized condition and have partially migrated to the grain boundaries. Number 3 shows the structure representing that of a normal low carbon steel.

Fig. 4. Tube section which has been bulged due to overheating

Continued firing of this tube would eventually cause it to burst. Note the deposit is still in place. This restricts cooling of the tube metal.

The practical success of volatile neutralizing inhibitors in many mills is limited because:

1. There is no protection against dissolved oxygen attack.
2. Close continuous control of the feed rate is required to keep pace with variations in carbon dioxide input.
3. An overfeed of certain products (e.g., ammonia) can result in damage to copper or copper alloys in the system.
4. Treatment can be costly if carbon dioxide concentration of steam is appreciable.

FILMING AMINE TREATMENT

Filming-type amines (octadecylamine-base inhibitors) produce an organic film on surfaces contacted by the condensate. This film adheres tightly but will not build up to interfere with heat transfer. One product, Hagafilm, has been marketed for the past 10 years by Hagan Chemicals & Controls, Inc. It is successfully being used in many high-pressure central stations as well as paper mills (*3*, *4*, *5*). Hagafilm is a mixture of acetate salts of octadecylamine and other shorter chain amines. It is available as a technical grade flaked solid or as an emulsion.

When added to a boiler, Hagafilm distills and is carried throughout the system with the steam. At points of condensation, the amine forms a thin, nonwettable film on all surfaces—piping, valves, driers, wet ends of turbines, heaters, etc. This physical barrier separates the corrosive condensate from the metal, protecting against oxygen pitting as well as low pH carbon dioxide corrosion.

Solutions of Hagafilm prepared in hot condensate are pumped continuously to the boiler feedwater, condensate returns, or to steam lines. The exact amount of the amine required to provide the desired protection will vary from system to system, depending upon severity of corrosion, surface area to be protected, flow rates, temperatures, and composition of the condensate. Usually 1 to 2 p.p.m. based on total steam flow is sufficient. Precise control over the concentration is not required. Underfeeding provides slightly less

than optimum protection; overfeeding is undesirable from an economic standpoint.

What does it cost to treat the condensate system with filming inhibitor? Surprisingly little when the benefits are considered. Based on average inhibitor usage, the cost is only $1.15 to $2.30 per million pounds of steam generated.

CONTROLLING FEED RATES

The most direct method of evaluating and controlling the feed of Hagafilm is on the basis of iron and copper test results. Preweighed corrosion test specimens inserted in condensate lines give another means of determining the effectiveness or protection. Corrosion rates are calculated from specimen weight losses during a test period (a minimum of 30 days). Test specimens are best installed at points where treated steam has the greatest distance to travel from the boiler or where there has been a past history of pipe replacement and corrosion. Visual inspection of the specimens shows whether the attack is etching or pitting. Evidence of severe pitting indicates an area of oxygen in leakage which should be eliminated. With these procedures as guides, adjustments in inhibitor feed rates can be made and optimum conditions established.

Because Hagafilm forms a film, it exerts a detergent action on old corrosion products, process contaminants, and organic material in the return system. This cleaning action is beneficial as it may result in improving heat transfer (*6*). For example, after amine treatment, one paper mill reported a 20°F. temperature increase in surface drier temperature. In another, 80 more feet per minute of paper were produced after treatment.

In order to control the rapidity of the cleanup and to prevent redeposition of the material at other points in the system, less than the calculated amount of inhibitor is usually fed initially. Increases are made under controlled conditions until the optimum feed rate is reached. The degree of cleanup, of course, depends upon the condition of the system before the start of treatment. As deposits are sloughed off, they must be removed from the cycle.

There may be some increase in trap maintenance for a time after startup of filming amine treatment. Leaks may break open in lines where oxide plugs are removed. Some replacements of parts already seriously damaged and about to fail may be necessary. As treatment progresses and old deposits are purged from the system, maintenance will naturally decrease.

FILTERING CONDENSATE

As an adjunct to filming amine treatment, condensate filtration is recommended. This will remove debris and protect high-pressure boilers during the cleanup period. All materials sloughed off by the cleaning action are suspended and, therefore, can be removed by filtration. Although the necessity of a condensate filter becomes less critical as amine treatment progresses and the system is protected, it is a worth-while piece of equipment. When systems are modified or enlarged and additional piping and equipment added, a filter will catch the miscellaneous debris (mill scale, pipe dope, welding beads, etc.) inevitably released from new sections. It also will remove corrosion products which form in equipment during stand-by periods. For instance, when heating systems go into service after the summer shutdown, considerable old corrosion products are returned with the condensate.

There is always a chance that condensate may become contaminated by process materials. These can come from evaporators, oil coolers, process heat exchangers, or condensers. Of course, contamination should be avoided and conductivity monitoring instruments with dump valves should be installed in areas where there is a possibility of process contamination. A slug of contaminated condensate can cause priming and carry-over of boiler water to turbines. However, filters are helpful in minimizing the effects of such contamination.

What type of filters are suitable for this service? In some cases returns are under pressure so that high temperatures are possible. Even with severe conditions such as this, the filter selected should not add iron or silica to the filtrate. Excess silica in boiler water volatizes at high temperatures and can be carried with steam to turbine blading where it deposits.

Many filters currently available have the desired operating characteristics (*7*). Fine stainless steel cartridges or leaf elements precoated with short fibers of pure cellulose have been used successfully to remove up to 90% of the suspended iron from condensate. Particles as small as 1 μ can be removed. However, condensate filtration alone does not effectively reduce copper concentration of condensate because copper, unlike much of the iron, is largely dissolved in the water.

As an added means of controlling the pickup of corrosion products, provisions should be made to monitor and dump, if necessary, condensate from machines or driers which are periodically down for wire changes of maintenance. When equipment is returned to service, corrosion products formed during stand-by are purged. Naturally, these slugs of corrosion products can be damaging. In some mills, untreated returns have not been acceptable for as long as 36 hr. after machines go back into service. During this time, condensate should be dumped to the sewer. It is not unusual for the contamination to be 30 or 40 times greater than the average. Since an organic amine film has lasting effects, condensate corrosion treatment is helpful in protecting driers, heat exchangers, and other equipment during stand-by periods, thus decreasing the length of time condensate must be wasted.

An individual test program should be conducted to determine the length of flush needed. To do this, special membrane filters can be piped to a sampling coil on a return line. A portion of condensate can be easily filtered through a pad having a controlled pore size. Suspended iron will be trapped on the surface of the pad and the extent of contamination readily determined from the discoloration. When the color on a pad approaches that observed in the main return stream, the condensate can be cut back into service. Standards can be prepared by filtering samples containing known amounts of iron. This procedure is much more rapid than the standard iron and copper determinations and can be used on condensate samples from paper machine driers as a part of the overall testing and control program.

INEFFECTIVE TREATMENT

Another question frequently asked is: what happens if we don't treat our condensate to keep iron and copper contamination down? Answer: tube failures or high costs for boiler maintenance and cleaning result. Of course, the degree of risk depends upon the design of the boilers and their specific operating conditions. If a boiler is pushed to maximum rating, naturally the chances of failures are higher than in a similar boiler with about the same contamination but operating at a lighter load. In one mill operating without a condensate corrosion inhibitor tube failures occur as frequently as every 2 months. In still another, it has been necessary to acid-clean boilers every 6 months to keep them in reasonable operating condition. The cost of an acid cleaning, in this case, is $8000 plus labor required during a three or four day outage.

Unscheduled boiler outages normally occur at the worst possible time, when the production department is using all the steam the boiler can make. The cost of an unscheduled outage in terms of lost production may be staggering.

Until an adequate condensate treatment program can be established, some mills waste condensate because of the high concentrations of iron and copper. They operate on either all deionized makeup or use "preferred" condensate, i.e., returns from turbine condensers and auxiliary equipment where corrosion product pickup is not significant. This procedure wastes both heat and water and, in many cases, puts an excessive demand on deionizers. Deionized water runs about 20¢ a thousand gallons plus the cost of the fuel to heat it to the prevailing feedwater temperature.

SUMMARY

If your mill anticipates the installation of a high-pressure boiler plant, you would do well to start a corrosion control program now—well ahead of the actual installation. Iron and copper testing will tell you where you stand and give you an idea of what steps are needed to make the condensate suitable for use in high-pressure boilers. When adequate provisions are made to control all phases of the water treatment program, the economic benefits of a high-pressure boiler system can be realized and the system's practical operation in a paper mill circuit is possible.

LITERATURE CITED

1. American Society of Testing Materials, Manual on Industrial Water and Industrial Waste Water, Second Edition, Philadelphia ASTM, 1960 (S.T.P. Number 148 D).
2. Partridge, E. P., Control of Copper and Iron Pick-up in Pre-Boiler System, Meeting of Production Committee, Southeastern Electric Exchange, Oct. 21, 1958.
3. White, J. P., "Filming Amines Reduce Corrosion at Arkansas Power & Light," *Power*, April, 1960.
4. Carr, H. E., "How a Corrosion Problem in a Dryer Condensate System Was Solved," *Paper Trade, J.*, March 21, 1960.
5. Galloway, E. E., Use of Filming Amine for Prevention of Corrosion in Condensate Systems, National Association of Corrosion Engineers, North Central Regional Conference, October, 1958.
6. Obrecht, M. F., "Filming Amine Inhibitors Control Corrosion, Improve Heat Transfer," *Heating, Piping and Air Conditioning*, November, 1959.
7. Levendusky, J. A. and Calise, V. J., Research Problems Relating to Production and Quality Control of Ultrapure Feedwater for Eddystone Station, ASME Paper No. 59-A-420.

Heat Transfer Printing

R. G. SHEPHERD, JR.

Heat transfer printing is becoming more and more important for decorating plastic bottles, moldings, films, and foils. A process is described which utilizes roll labels printed with thermoplastic inks on a carrier paper containing a fusible coating. Transfer of the ink film is effected by a rolling application of heat and pressure. Relatively fast application speeds are accomplished with a machine which accurately positions the ink designs on the receiving surface (packaging films and polyethylene bottles). A row of holes along the edge of the label web are used to maintain register in the applicator machine. Advantages of this process are discussed with particular emphasis on packaging.

An investigation of improved labeling methods has resulted in the development of a heat transfer process which gives high quality, multicolor printing on packaging films and plastic bottles.

Heat transfer printing is a two-step decoration process utilizing thermoplastic inks. In step 1, ink is printed on a temporary, or intermediate carrier material and allowed to dry. The printed image can be stored in this form until needed. In step 2, the ink is softened with heat and pressed against the surface to be decorated. The transfer operation is completed by removing the carrier sheet. During transfer a lateral reversal of the image occurs. When properly applied, the transferred print differs little in physical appearance from direct printing. Unlike decalcomanias, heat transfer printing does not rely on mechanical films to support the image during and after transfer; ink is essentially the only material transferred.

Heat transfer printing has several important advantages over decalcomanias: (1) no water or solvents are needed, decorated materials can be handled immediately after the print is applied; (2) the thin ink film conforms better to receiving surfaces than a decalcomania which contains a relatively thick supporting film; (3) the transfer operation is rapid and thus adaptable to automatic application; (4) lower production costs are possible because fewer coatings are needed. It is understandable that this process has been used commercially for years in such diverse applications as cigarette tax stamps and labeling of hosiery.

R. G. Shepherd, Jr., Dennison Manufacturing Co., Framingham, Mass.

AUTOMATIC HEAT TRANSFER PRINTING PROCESS

The interest that led to the development of the present process arose during a research project on heat seal label paper. Quantities of this paper are consumed as roll labels for automatic application on packaging machines. The aforementioned advantages made heat transfer printing look promising as a new roll-type product to supplement heat seal paper for automatic labeling. Thus a project was initiated to develop a product meeting the following requirements:

1. Printing should be of high quality. Before use the product should possess long shelf life, under normal shipping and storage conditions.
2. The prints should be spaced close to one another on continuous rolls containing punched index holes for automatic registration during application.
3. Each print should transfer cleanly without disturbing the adjacent print.
4. Transfer speed of the print should be fast enough at practical temperatures to permit use with most commercial packaging machines.
5. The transferred print should be distortion-free, adhere well over a wide temperature range, exhibit good abrasion resistance, and be unaffected by moisture and package contents.

The project resulted in the development of a relatively simple heat transfer printing system* comprising a thermoplastic ink printed on a paper carrier sheet coated with a fusible release material (Fig. 1). On heating with a platen shaped to match the print, the ink becomes tacky enough to bond with the receiving surface (packaging film or plastic bottle). The release material melts to a more fluid state than the ink and splits as the carrier paper is removed. Some of the release material transfers with the ink where it serves to enhance gloss and help protect the ink against moisture, package contents, and mechanical abrasion.

Despite the simplicity of the system, many compromises were required in developing the ink, release coating, and paper. The ink should exhibit a reasonably high blocking point for safe storage and transportation, coupled with a low heat activation point for high-speed application. On activa-

* Therimage®-patented process and product of Dennison Manufacturing Co.

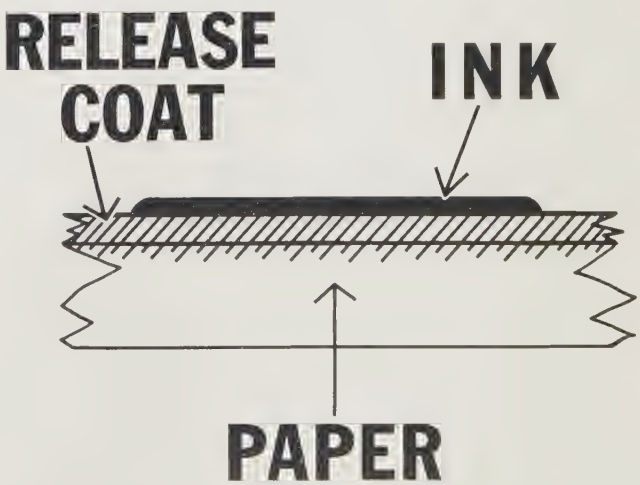


Fig. 1. Structure of heat transfer printing stock

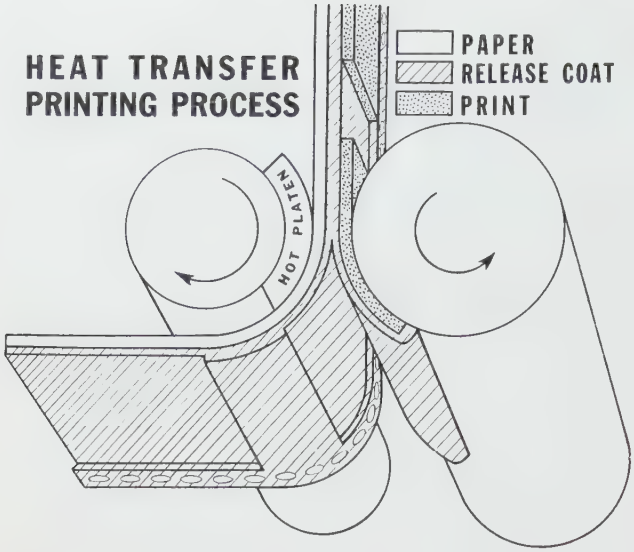


Fig. 2. Rolling method for transferring ink

tion the ink must flow enough to wet the receiving surface for good adhesion yet should retain sufficient internal cohesion to minimize distortion during transfer. The dry release coating should be ink receptive for good printing quality yet not mix with the ink when heated. When activated, the release coating should be fluid enough to quickly release the ink yet retain sufficient film strength to prevent the ink from locking to the carrier paper fibers.

Most major printing processes were examined to find the best way of producing the stock. Good results were obtained with samples printed by letterpress, offset, rotogravure, flexography, silk screen, and die stamping. Special inks were developed for each process. Ink drying problems complicated efficient production by letterpress and offset. Also, the web printing requirement restricted the letterpress process to platen-type printing presses that give prints of limited quality. Multicolor web-fed equipment with variable feeds are not presently available for offset, silk screen, and die stamping processes. Flexography does not produce the fine printing detail desired. Thus the rotogravure process was chosen since it offered printing quality, variable feed printing of webs, economy in long runs, and fewer restrictions in formulating inks.

Production is currently carried out on four or five-color gravure presses handling a 14-in. web. Slitting and dieing of registration holes are performed in line with the printing. Inasmuch as the shape of the print is relatively independent of the carrier paper, valuable production savings are possible with respect to printing rolls and dies. A complete range of print shapes and sizes can be supplied with only three diameters of gravure cylinders. The printing cylinders are prepared by a direct transfer process using a 150-line screen. Etching is carried out to give deep cells with comparatively wide walls. Good quality printing requires considerable care in making press adjustments. Printed stock is inspected and rewound on 3-in i.d. cores to an overall diameter of 10 in. Each roll leaving the printing department contains 2500 ft. of stock.

PERFORMANCE OF TRANSFER PRINTING STOCK

The thin ink film has little mechanical strength and must be uniformly transferred to the receiving surface (packaging film, bottle, etc.) Flaking of ink is certain to occur after transfer if bubbles are formed at the ink film-receiving surface interface. Bubbles can be avoided by rolling the print onto the receiving surface with a cylindrically shaped hot platen (Fig. 2). This technique has the further advantage of being mechanically compatible with continuous web-motion packaging machines. Rolling also facilitates peeling of the carrier paper as the print is transferred. The principal disadvantage of the rolling method is the short dwell time due to line contact between the hot platen and release paper. This must be compensated by high platen surface temperatures.

Figure 3 shows the relation of platen temperature to linear speed of a transfer printing during decoration of treated polyethylene film and heat-sealable cellophane. The minimum application temperature of this printing stock at infinite dwell is in the range of 220 to 240°F. Points on these curves were obtained by judging adhesion by the pressure-sensitive tape test. It is apparent that the nature of the receiving surface critically affects the rate of application. The superior decorating characteristics of cellophane as compared to polyethylene are partly due to the cellophane heat-seal coating. Thus when dealing with a variety of packaging materials, ink formulas must be tailored for optimum performance on each product.

A survey of the package machinery field revealed the transfer speeds of from 60 to 100 f.p.m. were fast enough to qualify the process for use on many types of commercial packaging equipment.

The decision to transfer the print using a rolling application of heat and pressure created a machine problem. A survey of commercial labeling equipment revealed that no machines were available that could be readily adapted to apply the printing stock by the rolling method. Thus a machine design program was initiated which resulted in the development of two machines: (1) a compact unit requiring external power for use with packaging machines handling films, cartons, and other flat surface objects; (2) a self-powered unit (Fig. 4) for decorating bottles, tubes, and other complex shapes. Both machines handle printed roll stock containing a row of registration holes $^1/_8$ in. diam., $^1/_2$ in. on center.

TRANSFER PRINTING ON PACKAGING MATERIALS

In the smaller transfer printing machine power is mechanically drawn from the parent machine. The transfer stock is indexed past an electrically heated roller which holds replaceable platens shaped to the contour of the print. A resistance probe temperature controller permits reliable operation up to 800°F. The index drum and platen holder are actuated by a solenoid and clutch triggered from a micro switch or electric eye on the parent machine. Prints can be applied at speeds up to 120 f.p.m depending on the nature of the receiving surface and print area.

When mounted on a packaging machine, effects are obtained equivalent to those resulting from a four or five-color gravure press. Despite the added cost of carrier paper, transfer printing can be considerably less expensive than direct printing where the ratio of print area to packaging material area is low. The break-even point is roughly 10%.

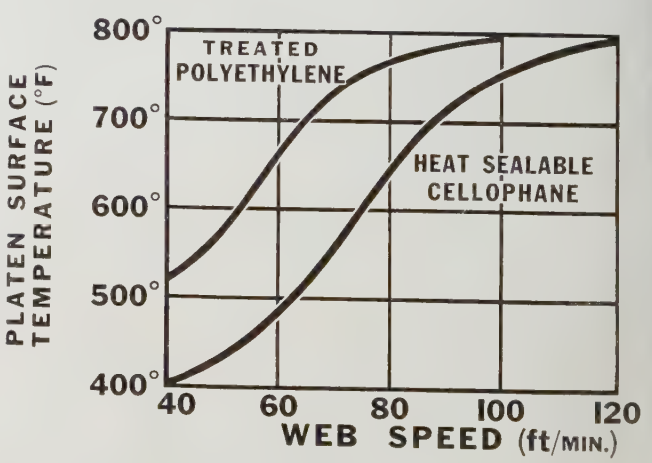


Fig. 3. Effect of transfer speed and platen temperature on ink adhesion

In situations where the print area ratio is high, savings are often possible due to lower inventory requirements for packaging films, particularly when an expensive material is used.

Transfer labels with metallic backgrounds can be used to overprint preprinted packaging materials. Thus obsolete wrappers can be recovered by correcting ingredient lists or deleting old premium offers, etc.

DECORATION OF PLASTIC BOTTLES

The bottle decorating machine consists of a basic unit containing feed, indexing, and takeup rolls. The punched stock is accurately sequenced past a bottle-holding turret and cylindrical platen operating at 600 to 700°F. Turret and platen are interchangeable to accommodate plastic containers of many shapes including cylinders, ovals, oblongs, tapered ovals, and tapered rounds (Fig. 5). The machine handles containers with capacities up to a quart. Change gears and sprockets, and two adjustable shuttles are used to synchronize the turrets, platen, and label web.

Entering from a feed conveyor (Fig. 4) the containers pass into the turret section where they are oriented to receive the print. Oval and oblong containers are held in cradles; cylinders are forced down into a revolving cup by an air cylinder which rotates each container and indexes it from the neck thread so that mold marks are always in the same position with respect to the label. An air cylinder then engages the bottle, holds it in place, and inflates it with air at 2 to 10 lb. pressure to provide a firm surface for applying the print. The heat transfer stock is fed from a roll around an indexing cylinder. The latter has pins that engage the holes on the web for proper registration with the platen and turret. The rotating platen, synchronized with the container, applies heat and pressure through the back of the moving paper web. As the print transfers to the container, the carrier paper is peeled away and rewound on a takeup roll.

A unique feature of the machine is the paper handling arrangement. Both unwind and rewind rolls always operate at constant speed. Overtravel of the web between transfer cycles is compensated by a walking beam which moves the web back in time to register the succeeding print with the next container. The machine cycles at speeds up to 150 containers per minute. However, the rate controlling factors on actual production output are heat conductivity and print-

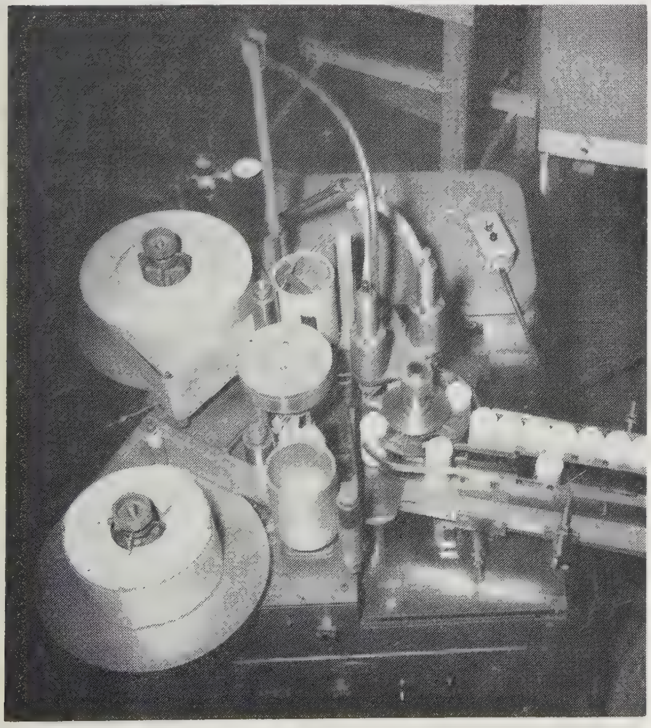


Fig. 4. Plastic bottle decorating machine

Fig. 5. Plastic containers decorated by heat transfer printing

receptivity of the container material. For example, low density polyethylene containers can be decorated at higher speeds than those molded of high density polyethylene.

Higher production speeds and improved appearance are obtained by heat-treating the bottles after application of the print. With this treatment the printing can be applied at high speed without giving consideration to adhesion. Post heating "sets" the ink and flows the release coating sufficiently to impart a brilliant gloss to the print. Precise control of postbaking is necessary to obtain optimum gloss without damaging the container. This is accomplished in a 38 ft. oven containing three heating sections operating at 400, 220, and 200°F., respectively, and a cooling section. The containers move through the ovens on a conveyor belt. Travel time through the oven is approximately 3 min.

Before the process was developed, plastic containers were decorated by screen printing, hot stamping, paper labeling, and dry offset. The first two processes are limited in reproducing finely detailed copy; and expensive for multicolor printing. Paper labels wrinkle when the container is flexed. Dry offset printing has relatively low hiding power, does not reproduce process half tones well, and is difficult to apply on noncylindrical containers.

Transfer printing by the gravure process has created considerable interest because of the wide range of printed effects possible, brilliant glossy surface, adaptability to many shapes and sizes of containers, durability and lower cost when large quantities of containers are involved.

FUTURE DEVELOPMENTS

Heat transfer printing is rapidly becoming established as an important auxiliary operation to other graphic arts processes. Further expansion will occur following development of short run production techniques. An imprinting feature for adding batch numbers and ingredient changes should extend the use of this process. New applicating machine developments are expected which will broaden the use of heat transfer printing in the decoration of a wider variety of plastic molded objects, flat folded cartons, etc. A bright future is also seen in the glass container field where this technique could prove invaluable in the production of single-trip and returnable glass containers.

It appears likely that the broad spectrum of new materials being developed for the packaging industry and new advances in fabricating equipment will result in many new containers that require high quality decorations not easily obtained by direct printing. Heat transfer printing will supply a practical answer to many of these problems.

Received Jan. 18, 1961. Presented at the 46th Annual Meeting of the Techinal Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23 1961.

UNITED STATES PATENTS ON PAPERMAKING

First Quarter, 1961 — *Compiled by The Institute of Paper Chemistry*

THE following list of United States patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture. Copies of any of the following patents may be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired. Or, those desiring the patents on *microcards* should write to The Institute of Paper Chemistry, Appleton, Wis.

Jan. 3, 1961

Arledter, Hanns F., and Piepenbrink, Hans-Frank. **Process for coating a substrate with a mixture of a polyhydroxy polyester and a polyisocyanate.** U. S. pat. 2,967,117. Filed May 20, 1955. 7 claims. Assigned 50% to Farbenfabriken Bayer AG. Leverkusen, and 50% to Mobay Chem. Co. [Cl. 117-106.] Paper is coated or impregnated.

Beersma, Pieter J. A., and Moes, Geert. **Method of manufacturing starch products.** U. S. pat. 2,967,110. Filed Nov. 14, 1955. 16 claims. Assigned to Naamloze Vennootschap W. A. Scholten's Chemische Fabrieken. [Cl. 106-206.] The product is of use in sizing paper.

Crowther, Fred A., and Daroux, William G. **Disposal of effluent.** U. S. pat. 2,966,865. Filed July 30, 1957. 2 claims. Assigned to Courtaulds, Ltd. [Cl. 110-7.] Spent pulping liquor is evaporated and the residue oxidized.

Cuffey, William H., Jr., and Sitterson, Cephas B., Jr. **Cellulosic product.** U. S. pat. 2,967,010. Filed March 21, 1958. 3 claims. Assigned to Kimberly-Clark Corp. [Cl. 229-51.] A dispensing carton is provided for packaging facial tissues.

Forrer, Homer W., and Wood, Prentice J. **Paperboard carrier.** U. S. pat. 2,967,003. Filed Oct. 9, 1959. 4 claims. Assigned to The Mead Corp. [Cl. 220-114.] This is a six-pack bottle carrier.

Glucksman, John I. **Vacuum and pressure control valve for printing presses.** U. S. pat. 2,967,054. Filed May 22, 1958. 3 claims. Assigned to Mergenthaler Linotype Co. [Cl. 271-5.]

Hollinger, William K., Hollinger, Robert H., and Patterson, Alvis R. **Paperboard and method of manufacture.** U. S. pat. 2,967,116. Filed Aug. 20, 1957. 6 claims. Assigned to Control Pak Corp. [Cl. 117-102.] A water-resistant wax-impregnated corrugated board food carton is prepared.

Lammers, Delmar R. **Protective tray for cartons.** U. S. pat. 2,967,002. Filed July 2, 1956. 6 claims. [Cl. 220-85.] A paperboard milk carton is provided with a plastic supporting tray.

Leibreich, Norman A. **Heading machine for forming containers.** U. S. pat. 2,966,833. Filed Feb. 10, 1958. 10 claims. Assigned to Mead Corp. [Cl. 93-55.1.] End closure disks are fitted to fiber drums.

Lidgard, Edward J. **Container for sheetlike material.** U. S. pat. 2,967,009. Filed Dec. 19, 1957. 12 claims. Assigned to Flotepak Corp. [Cl. 229-14.] A shipping carton for glass windshields is provided.

Sabine, Hale J. **Acoustical correction element.** U. S. pat. 2,966,954. Filed July 11, 1957. 6 claims. Assigned to Celotex Corp. [Cl. 181-33.] The element consists of two spaced perforated sheets of paper or board.

Steinle, Josef. **Machine for introducing or extracting bottles into or from bottle cases.** U. S. pat. 2,966,995. Filed Oct. 25, 1957. 8 claims. Assigned to Certus Maschinenbau G.m.b.H. [Cl. 214-309.]

Thumim, Carl. **Hydraulic control system for clamp of paper cutting machine.** U. S. pat. 2,966,889. Filed Feb. 4, 1957. 2 claims. Assigned to Miehle-Goss-Dexter, Inc. [Cl. 121-38.].

Trogman, William. **Folding boxes and handles therefor.** U. S. pat. 2,967,011. Filed June 10, 1959. 4 claims. [Cl. 229-52.] A separate plastic handle is provided for a flat garment carton.

Vergobbi, John G. **Container forming machine.** U. S. pat. 2,966,832. Filed Aug. 20, 1958. 13 claims. Assigned to Pneumatic Scale Corp., Ltd. [Cl. 93-12] A lined carton is formed.

Weil, Lester L. **Nitrocellulose compositions and method for making same.** U. S. pat. 2,967,098. Filed Oct. 26, 1954. 20 claims. Assigned to Atlantic Research Corp. [Cl. 52-5.]

Wolff, Hans. **Starch ethers.** U. S. Re. pat. 24,919. Filed July 20, 1960. (Original filed Feb. 2, 1960.) 6 claims. Assigned to A. E. Staley Mfg. Co. [Cl. 260-233.3.] The product is of use in sizing paper.

Zilver, Edwin. **Method and an apparatus for filling match boxes with matches.** U. S. pat. 2,966,768. Filed Sept. 19, 1958. 23 claims. Assigned to N.V. Inland. [Cl. 53-148.]

Jan. 10, 1961

Allen, Frank D., Van Allan, James A., and Sagura, John J. **Thermographic copying material.** U. S. pat. 2,967,785. Filed Aug. 14, 1959. 11 claims. Assigned to Eastman Kodak Co. [Cl. 117-36.]

Barnes, Bernard C. **Carton sealing machine.** U. S. pat. 2,967,387. Filed Sept. 22, 1958. 11 claims. [Cl. 53-373.] Gable-top milk cartons are sealed.

Baumer, Earl F. **Brick package.** U. S. pat. 2,967,612. Filed July 17, 1959. 8 claims. [Cl. 206-65.] Paperboard edge protectors are used.

Bolinger, George F. **Carton for merchandising display cards.** U. S. pat. 2,967,611. Filed Nov. 17, 1958. 3 claims. Assigned to Sta-Rite Ginnie Lou, Inc. [Cl. 206-57.]

Canfield, Gerald L., and Schelske, Billy J. **Foil cup and package and method of producing same.** U. S. pat. 2,967,652. Filed Nov. 7, 1958. 3 claims. Assigned to Ekco-Alcoa Containers Inc. [Cl. 229-5.5.] Improved sealing of the cup with a paperboard closure disk is provided.

Ebert, Robert W., Sheerin, Harry J., and Leckley, Philip A. **Sheet dispensing package.** U. S. pat. 2,967,610. Filed Feb. 6, 1958. 1 claim. Assigned to Kimberly-Clark Corp. [Cl. 206-57.] A dispensing carton for paper napkins or the like is provided.

Friday, Paul D. **Continuous in line pulp molding machine.** U. S. pat. 2,967,568. Filed Aug. 5, 1957. 22 claims. Assigned to Paper Maid, Inc. [Cl. 162-407.]

Gabbard, Elbert S. **Combined paper cup and package.** U. S. pat. 2,967,609. Filed Oct. 28, 1957. 2 claims. Assigned to Goldene Shaw. [Cl. 206-57.] A paper packet for a mouthwash powder or the like includes an integral fold-out cup for mixing the powder with water.

George, Herbert E., and Coupland, Albert E. **Web feeding and control device for printing machines.** U. S. pat. 2,967,479. Filed Dec. 30, 1958. 7 claims. Assigned to George & Miller, Ltd. [Cl. 101-228.] Printing impressions are registered with marginal perforations in the web.

Jakaitis, Eugene A. **Wax coating composition and paperboard coated therewith.** U. S. pat. 2,967,781. Filed Oct. 7, 1959. 7 claims. Assigned to Atlantic Refining Co. [Cl. 106-270.]

Kushner, Bernard. **Letterheads and the like.** U. S. pat. 2,967,657. Filed Sept. 24, 1957. 7 claims. [Cl. 229-92.3.] This is a windowed single-sheet mailing device.

Lindemann, Robert E. **Sheet feeder.** U. S. pat. 2,967,705. Filed Aug. 13, 1956. 16 claims. Assigned to Harris-Intertype Corp. [Cl. 271-26.] This is a printing press sheet-feeder.

Manas, Herman D., and Manas, Roy J. **Labeling machine.** U. S. pat. 2,967,636. Filed April 7, 1959. 21 claims. Assigned to M. R. M. Machinery Co., Inc. [Cl. 216-54.]

Marple, Stanley, Jr., Olson, Robert J., and Bartay, Delmar M. **Wax product comprising two paraffin waxes and an isoparaffinic-naphthenic plastic wax.** U. S. pat. 2,967,817. Filed April 30, 1956. 6 claims. Assigned to Shell Oil Co. [Cl. 208-21.] The composition is of use in coating food cartons.

Moffitt, William R., and Berkey, Morris B. **Adhesive comprising phenol aldehyde resin and water dispersible gum.** U. S. pat. 2,967,835. Filed Nov. 15, 1954. 4 claims. Assigned to The Borden Co. [Cl. 260-17.2.] The adhesive is of use in hardboard.

Newman, Douglas A., Schlotzhauer, Allen T., Vogel, Alfred M., Albert, Donald B., and Quattrone, Joseph J. **Thermographic copying paper.** U. S. pat. 2,967,784. Filed May 2, 1958. 6 claims. Assigned to Columbia Ribbon & Carbon Mfg. Co., Inc. [Cl. 117-36.]

Pasini, Franco. **Paper screening tapes for high tension electric**

cables. U. S. pat. 2,967,902. Filed Match 14, 1957. 4 claims. Assigned to Pirelli Societa per Azioni. [Cl. 174-102.]

Patzer, William A. **Currency testing and selecting device.** U. S. pat. 2,967,452. Filed May 2, 1958. 10 claims. Assigned to Seth B. Atwood. [Cl. 88-14.] Paper sheets such as currency are sorted in accordance with the indicia printed thereon.

Protz, William F. **Tinsel packaging carton.** U. S. pat. 2,967,653. Filed Aug. 8, 1956. 1 claim. Assigned to National Tinsel Mfg. Co. [Cl. 229-30.]

Reinhardt, Lothar, Muhldorf, Kreis, and Stecher, Friedrich. **Treatment of cellulosic materials.** U. S. pat. 2,967,765. Filed Nov. 6, 1956. 1 claim. Assigned to Wasag-Chemie A.G. [Cl. 23-285.] An apparatus is provided for completely defibering and suspending pulp sheets to form a mass suitable for esterification.

Seger, Gaylord R., Jr. **Polygonal carton.** U. S. pat. 2,967,655. Filed May 19, 1958. 2 claims. Assigned to Massillon Container Co. [Cl. 229-37.] The carton has flat-folding integral end closure flaps.

Swartz, Richard L. **Suction pick-up head.** U. S. pat. 2,967,731. Filed Sept. 30, 1957. 6 claims. Assigned to Universal Business Machines, Inc. [Cl. 294-64.] This is a sheet-feeding device.

Thorson, Benjamin N. **Method of and apparatus for disintegrating and dispersing a molten smelt stream.** U. S. pat. 2,967,758. Filed June 21, 1956. 8 claims. Assigned to The Babcock & Wilcox Co. [Cl. 23-48.]

Utley, Mulon T. **Beverage containers.** U. S. pat. 2,967,776. Filed Dec. 18, 1957. 1 claim. [Cl. 99-171.] A paper cup has a bottom compartment for holding a beverage powder.

Vergobbi, John G. **Package.** U. S. pat. 2,967,656. Filed Sept. 10, 1957. 4 claims. Assigned to Pneumatic Scale Corp., Ltd. [Cl. 229-52.] The carton has a positive tuck flap closure, liner, and string handle.

Weschler, Joseph R., Lagally, Paul, and Lagally, Herta. **Method of forming paper containing titanous hydroxide and product thereof.** U. S. pat. 2,967,797. Filed Dec. 10, 1956. 7 claims. Assigned to Johnson & Johnson. [Cl. 162-158.] The paper has improved wet strength.

Jan. 17, 1961

Appelt, Edna. **Container structure.** U. S. pat. 2,968,394. Filed March 10, 1958. 1 claim. [Cl. 206-47.] A box for a bottle of medicine is provided with means to hold the bottle to the container wall on either the outside or the inside of the box.

Brown, Judd A. **Method and apparatus for making felts and batts from fibrous material.** U. S. pat. 2,968,068. Filed July 22, 1957. 11 claims. [Cl. 19-155.] A process for felting wood fibers and the like involves vibrating a loose layer of the fibers.

Cantrell, Claude J., Sr. **Container.** U. S. pat. 2,968,397. Filed Feb. 24, 1958. 2 claims. Assigned to Esso Research and Eng. Co. [Cl. 206-65.] This is a large paperboard container for holding several bales of rubber.

Coplen, Milo G. **Plant container.** U. S. pat. 2,968,124. Filed May 10, 1957. 5 claims. [Cl. 47-37.] The paperboard container is designed for easy removal from the plant in transplanting.

Craighead, Prevost. **Gusseted pasted valve bags.** U. S. pat. 2,968,432. Filed Dec. 24, 1958. 3 claims. Assigned to Bancroft Bag Factory, Inc. [Cl. 229-62.5.]

De Mallie, Howard R. **Method and apparatus for forming connected boxes.** U. S. pat. 2,968,137. Filed Oct. 28, 1957. 13 claims. Assigned to Eastman Kodak Co. [Cl. 53-14.] Cartons of photographic film are taped together.

Derderian, Edward J. **Carton opening machine.** U. S. pat. 2,968,226. Filed Sept. 23, 1958. 12 claims. [Cl. 93-53.]

Erickson, Harold E., Riley, Robert W., and Shubert, Dale L. **Prepressing and dividing particle mats.** U. S. pat. 2,968,389. Filed May 3, 1957. (Divided; original led May 17, 1956.] 9 claims. Assigned 50% to Schubert and 50% to Ind. Dept. Co. [Cl. 198-218.] The mats are for wood-particle board.

Fisher, John V. **Carton package.** U. S. Re. pat. 24,925. Filed July 11, 1960. (Divided; original filed June 2, 1959.) 3 claims. Assigned to Container Corp. of America. [Cl. 206-65.] A six-pack can carrier is provided.

Giebel, Ernest W. **Windshield shipping carton.** U. S. pat. 2,968,395. Filed Jan. 28, 1959. 14 claims. Assigned to Union Bag-Camp Paper Corp. [Cl. 206-62.]

Glab, William T. **Methods of making a lignocellulose product and products resulting therefrom.** U. S. pat. 2,968,573. Filed Sept. 25, 1958. 2 claims. Assigned to Durel, Inc. [Cl. 106-163.] Lignocellulose is mixed with ammonia and heated under pressure to form a molding composition.

Glab, William T. **Methods of making a lignocellulose product and products resulting therefrom.** U. S. pat. 2,968,574. Filed Oct. 6, 1958. 2 claims. Assigned to Durel, Inc. [Cl. 106-163.] Lignocellulose and lignin are mixed and heated under pressure to form a moldable extrudable composition.

Jones, Dwight E. **Refining discs.** U. S. pat. 2,968,444. Filed Nov. 7, 1956. 3 claims. Assigned to E. D. Jones Corp. [Cl. 241–163.]

Knefel, Emanuel A. **Card processing apparatus.** U. S. pat. 2,968,480. Filed April 24, 1959. 12 claims. Assigned to The Magnavox Co. [Cl. 271-39.] Means are provided to position a magazine of cards in a feeding station so that the cards may be fed to a business machine processing the cards.

Kress, Bernard H. **Method of insolubilizing polymeric hydroxyl-bearing compounds.** U. S. pat. 2,968,581. Filed Jan. 15, 1957. 15 claims. Assigned to Quaker Chem. Prods. Corp. [Cl. 117-139.5.] The compounds include starches and cellulose derivatives; the process may be used in treating paper with starch.

Mariner, Thomas. **Method of improving the sound absorption efficiency of perforated porous acoustical materials.** U. S. pat. 2,968,327. Filed June 18, 1957. 11 claims. Assigned to Armstrong Cork Co. [Cl. 144-322.]

Martin, Kenneth P., and Nadaskay, Richard J. **Dielectric heat setting of a book binding adhesive.** U. S. pat. 2,968,336. Filed Feb. 24, 1958. 5 claims. Martin's interest assigned to Colonial Press, Inc., and Nadaskay's interest assigned to National Starch Prods., Inc. [Cl. 154-41.]

Martin, Kenneth P., and Rowland, Walter P. **Electronically controlled book case strip feed mechanism.** U. S. pat. 2,968,430. Filed Dec. 13, 1956. 3 claims. Assigned to The Colonial Press, Inc. [Cl. 226-32.]

Mehlhorn, Carl E., and Roberts, Franklin B. **Gum wrapping machine.** U. S. pat. 2,968,139. Filed Sept. 16, 1959. 2 claims. Assigned to Package Machinery Co. [Cl. 53-223.]

Monaco, Ugo, Olona, Olgiate, and Zanaboni, Piero. **Process for the continuous production of corrugated laminates.** U. S. pat. 2,968,335. Filed April 6, 1955. 8 claims. Assigned to Montecatini, Societa Generale per l'Industria Mineraria e Chimica. [Cl. 154-33.05.] A corrugated fiber-resin laminate is formed.

Pearson, Reinhold A., and Weremiczyk, Benny. **Alternate delivery attachment for box setting up machines.** U. S. pat. 2,968,388. Filed Sept. 29, 1959. 4 claims. [Cl. 198-33.]

Pellaton, Ernest C. **Carton for dispensing paper or like products.** U. S. pat. 2,968,431. Filed June 9, 1958. 3 claims. Assigned to Fibreboard Paper Prods. Corp. [Cl. 229-17.]

Peterson, Philip A. **Paper coating machine.** U. S. pat. 2,968,279. Filed Feb. 26, 1959. 3 claims. [Cl. 118-407.] A trailing blade coater has two coating heads on the same roller, so that either side of the paper may be coated.

Phillips, Floyd L. **Hosiery package.** U. S. pat. 2,968,393. Filed Nov. 13, 1958. 5 claims. Assigned to Old Dominion Box Co., Inc. [Cl. 206-46.] A paperboard device is provided for packaging hosiery.

Powell, Edward R. **Method and apparatus for cleaning and felting fibrous material.** U. S. pat. 2,968,069. Filed Jan. 30, 1956. 13 claims. Assigned to Johns-Manville Corp. [Cl. 19-156.] The fibrous material is mineral wool; insulation felts are formed by airlaying after the fibers are cleaned of shot.

Pratt, Robert H. **Article separating packages for flat articles such as surgical supplies.** U. S. pat. 2,968,396. Filed Dec. 7, 1959. 5 claims. Assigned to Laukhuff-Pratt Mfg. Corp. [Cl. 206-63.2.] A paper packet for surgical sponges is provided.

Saunders, George H., and Hedberg, Harold S. **Continuous pulp bleaching method.** U. S. pat. 2,968,589. Filed March 17, 1958. 2 claims. Assigned to Kimberly-Clark Corp. [Cl. 162-19.]

Schwebs, Robert K. **Carton.** U. S. pat. 2,968,392. Filed Dec. 11, 1958. 11 claims. Assigned to American Box Board Co. [Cl. 206-45.14.] This is a produce display box.

Sparks, George C. **Tear-strip pill package.** U. S. pat. 2,968,391. Filed June 19, 1958. 8 claims. [Cl. 206-42.]

Taylor, Norman W. **Apparatus for feeding sheets from a pile.** U. S. pat. 2,968,481. Filed May 15, 1958. 21 claims. Assigned to Harris-Intertype Corp. [Cl. 271-62.] Various improvements are made in a pile-elevating sheet feeder.

Toennies, Owe M. **Card feeding device.** U. S. pat. 2,968,138. Filed Feb. 4, 1959. 2 claims. Assigned to Grove Research and Devt. Co. [Cl. 53-196.] Paperboard wrappers are fed to a machine for assembling the wrapper with a stack of sliced meat.

Jan. 24, 1961

Baxter, Joseph, Jr. **Paper machinery.** U. S. pat. 2,969,114. Filed Oct. 13, 1958. 23 claims. Assigned to The Black-Clawson Co. [Cl. 162-348.] The sheet is formed by extruding the stock downwardly into the nip of two breast rolls about which are trained the downward flights of two wires between which the sheet is formed.

Brookhyser, Byron B., Erickson, Harold E., and Schubert, Dale L. **Feeding apparatus for rotary wood flaker.** U. S. pat. 2,969,095. Filed Aug. 30, 1957. 10 claims. Assigned to Ind. Devt. Co. [Cl. 144-242.]

Cook, Henry W. **Machine for folding newspapers.** U. S. pat. 2,969,232. Filed July 9, 1957. 6 claims. [Cl. 270-68.]

Finger, Joseph S. **Method of making a synthetic resin panel with a crinkled finish.** U. S. pat. 2,969,301. Filed Jan. 24, 1955. 3 claims. Assigned to Johns-Manville Fiber Glass, Inc. [Cl. 154-106.] The mat is a laminate of a fibrous nonwoven mat core and plastic cover sheets.

Ford, Barton H. **Grain door.** U. S. pat. 2,969,112. Filed April 17, 1957. 2 claims. Assigned 50% to Stanley Works, and 50% to Intern. Paper Co. [Cl. 160-368.] The door is formed of paper sheets about a plastic core with steel strapping elements also included.

Foreman, Lemuel R. **Debarking nozzle.** U. S. pat. 2,969,190. Filed Nov. 18, 1958. 3 claims. [Cl. 239-597.] A hydraulic barker is provided with an improved water-jet nozzle.

Franz, Erwin E. **Process for making printed circuits.** U. S. pat. 2,969,300. Filed March 29, 1956. 2 claims. Assigned to Bell Telephone Labs., Inc. [Cl. 154-96.]

Green, Frank B. K. **Pulp manufacture.** U. S. pat. 2,969,113. Filed Dec. 18, 1957. 9 claims. Assigned to Sprout, Waldron & Co., Inc. [Cl. 162-237.] A continuous digester is provided.

Green, Jerome. **Method of making paper.** U. S. pat. 2,969,302. Filed Feb. 14, 1957. 5 claims. Assigned to Nalco Chem. Co. [Cl. 162-164.] The retention of fines and fillers in paper is improved.

Hanson, Donald E., and Ormsbee, Mary K. **Photochemical stencil and method for manufacture.** U. S. pat. 2,969,014. Filed Feb. 19, 1958. 5 claims. Assigned to A. B. Dick Co. [Cl. 101-128.3.]

Hickin, Robert J. **Packaging method and apparatus.** U. S. pat. 2,968,898. Filed Dec. 10, 1958. 13 claims. Assigned to Pkg. Corp. of Am. [Cl. 53-26.] Six-pack bottle cartons are filled.

Holmes, Jack H. **Method of and apparatus for packing articles on trays.** U. S. pat. 2,968,899. Filed March 17, 1959. 29 claims. Assigned to Food Machinery and Chem. Corp. [Cl. 53-35.] Fruit or eggs are packed into the pockets of a molded pulp tray.

Johnson, Bertil. **Cartoner.** U. S. pat. 2,968,901. Filed Nov. 16, 1959. 24 claims. Assigned to Lynch Corp. [Cl. 53-230.] A flat carton blank is folded and glued about articles such as candy bars.

Jones, Delbert R. **Apparatus for making pull-tab type closures and method.** U. S. pat. 2,969,105. Filed Jan. 3, 1958. 9 claims. Assigned to Ekco-Alcoa Containers, Inc. [Cl. 154 1.6.] A disk closure for a container is provided with a pull-tab strip used to lift the disk from the container.

Malm, Carl J., Rowley, Martin E., and Hiatt, Gordon D. **Method of preparing cellulose sulfate.** U. S. pat. 2,969,355. Filed May 15, 1958. 12 claims. Assigned to Eastman Kodak Co. [Cl 260-215.]

Meyer-Jagenberg, Günther. **Method of and an apparatus for pre-folding or pre-creasing the closure forming components of a container of paper, cardboard and similar materials.** U. S. pat. 2,969,002. Filed Sept. 28, 1959. 3 claims. Assigned to Jagenberg-Werke Akt.-Ges. [Cl. 93-49.] The container is a gable-top milk carton.

Rapp, Raymond I. **Method of making envelopes.** U. S. pat. 2,969,003. Filed June 3, 1957. (Divided; original filed Dec. 23, 1954.) 1 claim. Assigned to William R. Peterson. [Cl. 93-63.]

Rose, Boyd W. **Sampling device for bag filling apparatus.** U. S. pat. 2,968,948. Filed May 18, 1956. 8 claims. Assigned to Food Machinery and Chem. Corp. [Cl. 73-421.]

Schubert, Dale L., Erickson, Harold E., and Riley, Robert W. **Mat forming method and apparatus.** U. S. pat. 2,969,104. Filed May 14, 1956. 36 claims. Assigned to Ind. Devt. Co. [Cl. 154-1.] The mat is for hardboard or wood-particle board.

Shelly, Robert S. **Multiple unit storage file.** U. S. pat. 2,969,269. Filed April 30, 1958. 4 claims. Assigned to Pack Mfg. Co. [Cl. 312-107.] The file, formed of interlocking paperboard containers, is provided with a fire-resistant metal jacketing.

Simerl, Linton E. **Coating process.** U. S. pat. 2,969,291. Filed June 10, 1957. 2 claims. Assigned to Olin Mathieson Chem. Corp. [Cl. 99-171.] Cellophane or other material is coated to provide a preservative wrapping material.

Touey, George P., and Kiefer, John E. **Preparation of sulfuric acid esters of cellulose.** U. S. pat. 2,969,356. Filed May 15, 1958. 7 claims. Assigned to Eastman Kodak Co. [Cl. 260-215.]

Toups, Harry S., Jr., Brand, Louis P., and Brand, Richard H. **Automatic bale trip mechanism for bagasse balers.** U. S. pat. 2,969,013. Filed May 2, 1958. 6 claims. Assigned to Thibodaux Boiler Works, Inc. [Cl. 100-4.]

Waldorf, Edmund H. **Combined wood and corrugated paper board structures.** U. S. pat. 2,969,170. Filed Sept. 4, 1957. 5 claims. Assigned to Tri-Wall Containers, Inc. [Cl. 229-23.] Means are provided for securing wood reinforcing elements within a corrugated shipping container.

Zackheim, Eli A. **Adhesive bandage.** U. S. pat. 2,969,144. Filed May 2, 1956. 18 claims. Assigned to Johnson & Johnson. [Cl. 206-63.2.] The protective paper strips used to cover the adhesive of a band-aid type bandage also form part of the outer wrapper.

Jan. 31, 1961

Archer, Irving M. **Apparatus for facilitating removal of bakery products such as rolls from baking pans and packing thereof in cartons.** U. S. pat. 2,969,633. Filed March 21, 1958. 13 claims. Assigned to Campbell Taggart Associated Bakeries, Inc. [Cl. 53-391.]

Behrens, Herbert C. **Flat bottom paper container.** U. S. pat. 2,969,901. Filed Oct. 31, 1956. 2 claims. Assigned to American Can Co. [Cl. 229-1.5.] A nestable flat-bottom frustoconical paper cup with improved sealing between bottom and side wall is provided.

Bischoff, Günther. **Papermaker's screen with a wavy longitudinal shape and edges longer than the center portion thereof.** U. S. pat. 2,969,581. Filed Sept. 13, 1956. 9 claims. [Cl. 28-78.]

Blais, Maurice E. **Packing apparatus.** U. S. pat. 2,969,629. Filed March 12, 1958. 8 claims. Assigned to St. Regis Paper Co. [Cl. 53-124.] Bags or other small containers are grouped and loaded into a large box.

Braun, Eric A. **Dispensing container.** U. S. pat. 2,969,905. Filed Dec. 1, 1958. 3 claims. Assigned to Ex-Cell-O Corp. [Cl. 229-17.] An improved closure is provided in a gable-top milk carton.

Cage, James. **Unitary sectionable containers.** U. S. pat. 2,969,902. Filed May 17, 1957. 1 claim. Assigned to Reynolds Metals Co. [Cl. 229-4.5.] A cylindrical package of paper and foil for shortening or the like, separable into individual sections as the packaged material is used, is provided.

Ceriat, Eugene. **Apparatus for forming tubular conduits from fibrous material.** U. S. pat. 2,969,836. Filed Nov. 20, 1958. 6 claims. Assigned to American Vitrified Prods. Co. [Cl. 162-295.]

Chambers, John K. **Package for adhesive bandages and other articles.** U. S. pat. 2,969,872. Filed June 5, 1957. 1 claim. Assigned to Seamless Rubber Co. [Cl. 206-63.2.] A sterile paper wrapper is formed about a band-aid or other article.

Claff, Chester E., and Moeller, Carl A. **Re-enforced box and box blank and method and machine for making the same.** U. S. pat. 2,969,906. Filed Nov. 24, 1959. 5 claims. Assigned to M. B. Claff & Sons, Inc. [Cl. 229-50.] A carton such as a shoe box is reinforced with rayon filaments at the corners.

Calybourn, Carlton C. **Vacuum slow down device for sheet delivery mechanism.** U. S. pat. 2,969,980. Filed Sept. 8, 1958. 7 claims. Assigned to Miehle-Goss-Dexter, Inc. [Cl. 271-68.]

Cottrill, Charles E. **Carton with integral pouring spout and blank therefor.** U. S. pat. 2,969,904. Filed July 24, 1957. 2 claims. Assigned to Standard Pkg. Corp. [Cl. 229-17.]

Edmonds, Frank A., and Doyle, Russell, P. **Process of tanning leather and product thus produced.** U. S. pat. 2,970,033. Filed Sept. 6, 1957. 2 claims. Assigned to American Cyanamid Co. [Cl. 8-94.33.] Lignosulfonates are used.

Faeber, Harry W. **Signature handling apparatus.** U. S. pat. 2,969,981. Filed June 13, 1958. 8 claims. Assigned to Time, Inc. [Cl. 271-82.]

Grade, Tullio E., and Jackson, John. **Cigarette packaging machine.** U. S. pat. 2,969,631. Filed March 9, 1959. 20 claims. Assigned to American Machine & Foundry Co. [Cl. 53-192.] A cigarette box having a sliding closure in the top panel is formed.

Hubert, Warren N. **Reinforced bag.** U. S. pat. 2,969,907. Filed April 15, 1958. 1 claim. Assigned to Dixie Wax Paper Co. [Cl. 229-55.] The bag described is formed of inner and outer separate waxed paper bags.

Hullinger, Clifford H., and Yui, Naoyuki H. **Process for preparing amino ethers of starch.** U. S. pat. 2,970,140. Filed Aug. 9, 1957. 4 claims. Assigned to American Maize Prods. Co. [Cl. 260-233.3.] The ethers are of use in paper coating and sizing.

Irmscher, Hans O. **Charge control mechanism in infusion package manufacture.** U. S. pat. 2,969,628. Filed May 22, 1957. 5 claims. Assigned to Natl. Tea Packing Co., Inc. [Cl. 53-28.]

Jordan, Wesley A., and Skagerberg, William E. **Process for making dispersible vegetable gums.** U. S. pat. 2,970,063. Filed March 12, 1958. 8 claims. Assigned to General Mills, Inc. [Cl. 106-208.] The gum may be carboxymethyl cellulose.

Keith, Clifford H. **Paperboard basket structure for fruit and the like.** U. S. pat. 2,969,903. Filed Sept. 18, 1957. 5 claims. Assigned to Mead Corp. [Cl. 229-16.]

Klacsmann, John A. **Surface coated impregnated waterleaf.** U. S. pat. 2,970,079. Filed May 22, 1956. 1 claim. Assigned to E. I. du Pont de Nemours and Co. [Cl. 162-164.] An impregnated synthetic fiber paper is provided for electrical insulation.

Leasure, William C. **Method and apparatus for packaging.** U. S. pat. 2,969,627. Filed Feb. 1, 1960. 14 claims. [Cl. 53-28.] This apparatus is of the type in which a tube of packaging material is formed and subjected to a series of filling, sealing, and severing operations to produce a series of separate packs.

McCahon, John O. **Machine for simultaneously pressing and forming joints in the hinge areas of cased books.** U. S. pat. 2,969,554. Filed Sept. 27, 1956. 15 claims. Assigned to R. R. Donnelley & Sons Co. [Cl. 11-1.]

Nelson, Alfred M., and Orner, Allan. **Card processing apparatus.** U. S. pat. 2,969,979. Filed March 12, 1957. 32 claims. Assigned to Magnavox Co. [Cl. 271-5.] A combination card-feeding and stacking station is provided in a machine for processing data cards.

Porth, Frank L. **Vitreous decalcomania and method of decorating ceramic articles.** U. S. pat. 2,970,076. Filed Jan. 14, 1957. 20 claims. Assigned to Meyercord Co. [Cl. 154-99.] A paper backing is included in the construction of the decal.

Reynar, John H. **Suction roll construction.** U. S. pat. 2,969,837. Filed June 10, 1958. 5 claims. Assigned to Layton-Greenfield, Inc. [Cl. 162-371.] Wear is reduced.

Rudes, George S. **Disposable cleanser pads.** U. S. pat. 2,969,626. Filed March 25, 1960. 4 claims. [Cl. 51-185.] The pad, impregnated with a detergent and a cleanser, includes various paper elements fastened together.

Schmittberger, Robert A. **Molding composition comprising a novolac resin, a furan derivative, and a filler, and process for making same.** U. S. pat. 2,970,121. Filed July 3, 1957. 13 claims. Assigned to Union Carbide Corp. [Cl. 260-17.2.] Wood flour, alpha pulp, lignin, and other materials are used as fillers.

Shenigo, Michael G. **Apparatus for packaging pallet-mounted bulky objects.** U. S. pat. 2,969,630. Filed Nov. 12, 1959. 21 claims. Assigned to West Virginia Pulp and Paper Co. [Cl. 53-138.] Cartons are applied to heavy articles such as furniture mounted on pallets.

Shenigo, Michael G. **Means for forming paperboard containers.** U. S. pat. 2,969,719. Filed May 26, 1959. 20 claims. Assigned to West Virginia Pulp & Paper Co. [Cl. 93-49.] The carton formed is for packaging nails or the like.

Sherman, Charles A. **Stick dropping mechanism.** U. S. pat. 2,969,892. Filed April 26, 1956. 8 claims. Assigned to Weyerhaeuser Co. [Cl. 221-210.] Spacers are inserted between board panels as the panels are stacked.

Young, Serenus H. A. **Molding shaped articles from fluid fibrous suspensions.** U. S. pat. 2,969,835. Filed Oct. 1, 1956. 13 claims. [Cl. 162-253.] Molded pulp articles are formed from a slurry of organic and glass fibers.

Zernov, Peter. **Continuous rewinder for web material.** U. S. pat. 2,969,930. Filed Sept. 22, 1958. 16 claims. Assigned to Mercury Eng. Corp. [Cl. 242-56.]

Feb. 7, 1961

Albus, Charles P., and Azorlosa, Julian L. **Hot melt adhesives containing polyvinyl methyl ether.** U. S. pat. 2,970,974. Filed Dec. 24, 1956. 7 claims. Assigned to General Aniline & Film Corp. [Cl. 260-27.] The adhesive is of use in laminating paper.

Baughan, Drury H. **Container system.** U. S. pat. 2,970,736. Filed Oct. 24, 1957. 3 claims. Assigned to Reynolds Metals Co. [Cl. 229-3.5.] A food container is formed of a laminate of foil, paperboard, and polyethylene.

Buurman, Aart, Vroom, Robbert A., and Limburg, Pieter C. **Manufacture of viscose rayon.** U. S. pat. 2,970,883. Filed Dec. 24, 1956. 8 claims. Assigned to American Enka Corp. [Cl. 18-54.] The reaction product of an alkylene oxide with an aldehyde or ketone is used as coagulation modifier.

Desbois, Theodore J. **Pallet.** U. S. pat. 2,970,797. Filed March 2, 1959. 7 claims. [Cl. 248-120.] The pallet is formed of paperboard.

Drummond, Warren W. **Radiation shielding fabric.** U. S. pat. 2,971,095. Filed March 23, 1955. 4 claims. Assigned to Bjorksten Research Labs., Inc. [Cl. 250-108.] The shield is a mat of ceramic fibers coated and bonded with lead.

Edlund, Melvin C. **Paperboard having a water-repellent coating.** U. S. pat. 2,970,932. Filed May 19, 1958. 2 claims. Assigned to Fibreboard Paper Prods. Corp. [Cl. 117-45.]

Eichorn, Robert N., and Hendrich, Henry A. **Cutting apparatus.** U. S. pat. 2,970,785. Filed Aug. 1, 1956. 15 claims. Assigned to Intern. Business Machines Corp. [Cl. 242-56.6.] Core-change means are provided in a paper web slitter-rewinder.

Erbach, Frederick R. **Control of stock supply in paper making machines.** U. S. pat. 2,970,938. Filed May 8, 1956. 10 claims. Assigned to Beloit Iron Works. [Cl. 162-212.] Stock is supplied to a cylinder machine without causing surface turbulence in the vat.

Findlay, Hugh T. **Carbon paper.** U. S. pat. 2,970,926. Filed Nov. 14, 1957. 4 claims. Assigned to Underwood Corp. [Cl. 106-171.]

Fisher, Charles T. **Flange bending machine for unstayed set-up box manufacture.** U. S. pat. 2,970,527. Filed March 20, 1958. 6 claims. Assigned to Harvey M. Crockett. [Cl. 93-51.]

Fleisig, Charles J. **Paper boxes for mailing.** U. S. pat. 2,970,742. Filed Jan. 28, 1959. 1 claim. [Cl. 229-45.]

Fleissner, Hans. **Machine for disintegrating a block of compressed fibrous and like material.** U. S. pat. 2,970,782. Filed Nov. 7, 1958. 4 claims. [Cl. 241-279.] A block of compressed cellulosic fibrous material, which has been caked for bleaching or other operation, is disintegrated.

Forkner, John H. **Food package.** U. S. pat. 2,970,920. Filed Dec. 19, 1957. 1 claim. [Cl. 99-171.] A waxed paper bag having sifter dispensing openings is used to pack a composition for use in preparing a gelatin dessert.

Fowle, Irving H., and Emminger, Francis J. **Self-erecting dispensing carton.** U. S. pat. 2,970,740. Filed April 30, 1958. (Divided; original filed June 7, 1957.) 3 claims. Assigned to General Aniline & Film Corp. [Cl. 229-38.] The carton includes an automatic bottom and is constructed for display purposes.

Gobalet, Kenneth C. **Pressure sections for box forming and box closing machines.** U. S. pat. 2,970,526. Filed Dec. 18, 1958. 23 claims. Assigned to Baljak Corp. [Cl. 93–36]. The freshly glued boxes are moved in a vertical direction through a pressure section in order to save floor space.

Gumbinner, Robert. **Stencil sheet having transferable back coating.** U. S. pat. 2,970,931. Filed March 25, 1957. 3 claims. Assigned to Polychrome Corp. [Cl. 117-35.5.] The stencil assembly produces a carbon at the same time the stencil is cut.

Hansen, Lester A., Baker, James H., and Keyes, Edward J. **Manufacture of coated abrasives.** U. S. pat. 2,970,929. Filed March 12, 1958. 4 claims. Assigned to Norton Co. [Cl. 117-17.]

Heath, Hillis H. **Egg carton.** U. S. pat. 2,970,734. Filed Aug. 4, 1958. 1 claim. [Cl. 229-2.5.] A hinged lid molded pulp egg carton is provided with improved lid-latching means.

Jacke, Raymond E., and Manning, Clarence F. **Food container for freezing and heating.** U. S. pat. 2,970,735. Filed May 10, 1954. 1 claim. Assigned to Reynolds Metal Co. [Cl. 229-3.5.] A food container comprises a metal tray with a lid formed of a board-foil laminate, and an overwrap of wax-laminated foil tissue material.

Johnson, Jerome E. **Holder for packaging phonograph records.** U. S. pat. 2,970,687. Filed March 3, 1958. 2 claims. Assigned to Tension Envelope Corp. [Cl. 206-62.] An interior packing member is provided to hold a phonograph record in the proper position within an outer envelope.

Jones, Lloyd W. **Composition and method for inhibiting scale.** U. S. pat. 2,970,959. Filed June 17, 1958. 18 claims. Assigned to Pan American Petroleum Corp. [Cl. 252-8.55.] Sodium carboxymethyl cellulose is used in a system for inhibiting the deposition of scale from oil field brines.

Joseph, Maurice J., Cox, Wilbert L., and Klein, Clarence F. **Carton.** U. S. pat. 2,970,743. Filed Jan. 27, 1956. 2 claims. Assigned to The Lord Baltimore Press, Inc. [Cl. 229-51.] A single-use carton for cake mix or the like is provided.

Justus, Edgar J., and Karr, Gerald W. **Automatic roll winder.** U. S. pat. 2,970,786. Filed May 22, 1958. 6 claims. Assigned to Beloit Iron Works. [Cl. 242–64.]

Kessler, Jack J. **Method of deleaving and bursting continuous form stationery.** U. S. pat. 2,970,784. Filed Oct. 19, 1956. 3 claims. Assigned to Narco, Inc. [Cl. 242–56.2.]

Klein, Clarence F., and Sexton, G. Stuart, II. **Sealed carton and method of forming.** U. S. pat. 2,970,525. Filed July 18, 1956. 2 claims. Assigned to The Lord Baltimore Press, Inc. [Cl. 93–36.] A leakproof end closure is formed on a frozen food carton made of waxed board.

Krueger, Theodore H., and Sharpe, Everett E. **Strip serving and applying device.** U. S. pat. 2,970,416. Filed June 7, 1955. 8 claims. Assigned to Better Packages, Inc. [Cl. 53-198.] A sealing band of tape is applied about the twisted neck of a filled bag.

Kumin, Victor M., and Hollister, John H. **Process for continuous purification of bulk fiber.** U. S. pat. 2,970,882. Filed Dec. 3, 1958. 9 claims. Assigned to The Kendall Co. [Cl. 8-108.] Unbleached cotton fibers are heated with caustic.

Levkoff, David. **Cartons.** U. S. pat. 2,970,739. Filed Oct. 23, 1958. 2 claims. Assigned 25% to Evelyn S. Levkoff, 25% to Henry S. Levkoff, and 25% to Edith L. Sennet. [Cl. 229–31.] An open-top elongated open-bottom tray for produce or the like is provided.

McWhirter, Eric M. S. **Document carrier for mechanized processing.** U. S. pat. 2,970,757. Filed March 24, 1954. 3 claims. Assigned to Intern. Standard Electric Corp. [Cl. 235-61.12.] An envelope made of paper or plastic is provided as a carrier for documents as the documents are processed by a business machine.

Martin, Samuel W., and Hanson, Walter J. **Letter feeding**

device. U. S. pat. 2,970,834. Filed Sept. 6, 1957. 4 claims. Assigned to Pitney-Bowes, Inc. [Cl. 271–26.]

Mayer, Louis. **Shipping and display carton.** U. S. pat. 2,970,685. Filed June 20, 1960. 7 claims. Assigned to Owens-Illinois Glass Co. [Cl. 206-44.]

Morgenstern, David. **Needled fabric and method.** U. S. pat. 2,970,365. Filed Aug. 4, 1958. 9 claims. [Cl. 28-72.2.] This is a nonwoven fabric of cellulosic or other fibers.

Mulvany, Richard B., and Barr, Gilbert R. **Egg handling device.** U. S. pat. 2,970,418. Filed March 6, 1958. 18 claims. [Cl. 53-251.] Egg cartons are filled.

Parks, Merwin S. **Machine for wrapping.** U. S. pat. 2,970,417. Filed Jan. 3, 1956. 5 claims. Assigned 50% to Theodore E. Nelson. [Cl. 53-226.] A wrapper sheet is sealed about a head of lettuce or the like.

Perry, Paul. **Candy suspension composition for food delicacies.** U. S. pat. 2,970,919. Filed March 19, 1959. 1 claim. Assigned to V. & E. Kohnstamm, Inc. [Cl. 99-140.] Sodium carboxymethyl cellulose is used.

Prichard, John H. **Composition comprising cellulose ester and diisocyanate modified polyester amide.** U. S. pat. 2,970,970. Filed July 16, 1958. 13 claims. Assigned to Celanese Corp. of Am. [Cl. 260-16.]

Rice, Alvist V. **Self-sealing container.** U. S. pat. 2,970,737. Filed June 19, 1959. 4 claims. [Cl. 229-7.] An improved top panel closure is provided in a carton for liquids which resembles a flat top milk carton.

Rohdin, Howard A. **Method and apparatus for blister packaging.** U. S. pat. 2,970,414. Filed Dec. 18, 1958. 18 claims. [Cl. 53-29.]

Schwebel, Adolf. **Pile lifting device for use in sheet printing machines.** U. S. pat. 2,970,835. Filed April 30, 1958. 13 claims. Assigned to MABEG Maschinenbau G. m. b. H. [Cl. 271-62.]

Silk, Charles E. **Purification of nitrocellulose.** U. S. pat. 2,970,996. Filed Sept. 19, 1951. 10 claims. Assigned to Olin Mathieson Chem. Corp. [Cl. 260–223.]

Slimowicz, Chester E. **Diazotype materials containing coupling components for high opacity ultraviolet yellows and visually dense sepias.** U. S. pat. 2,970,909. Filed Feb. 4, 1957. 4 claims. Assigned to General Aniline & Film Corp. [Cl. 96-91.]

Sottysiak, Joseph, and Harriman, Benjamin R. **Physical properties of photographic papers.** U. S. pat. 2,970,907. Field April 20, 1956. 8 claims. Assigned to General Aniline & Film Corp. [Cl. 96-85.] The paper has improved ferrotyping characteristics.

Strange, William M. **Sectioned container and blank therefor.** U. S. pat. 2,970,738. Filed Nov. 16, 1959. 6 claims. Assigned John Strange Carton Co. [Cl. 229-27.] Improved end panel constructions which facilitate overwrapping are provided in a sectional carton with integral hinged cover.

Stone, Orison W., and Campbell, Laurie H. **Closure for folding paperboard cartons.** U. S. pat. 2,970,741. Filed Sept. 22, 1959. 10 claims. Assigned to Continental Can Co., Inc. [Cl. 229-41.] The carton is the can carrier type.

Toby, Max E. **Method and apparatus for cutting paper sheets.** U. S. pat. 2,970,921. Filed July 7, 1958. 11 claims. Assigned to Toby Enterprises. [Cl. 99-171.] The cut sheets are immediately inserted between slices of meat or cheese in a stack.

Tolaas, William M. **Tape roll holder.** U. S. pat. 2,970,686. Filed March 20, 1959. 3 claims. Assigned to Waldorf Paper Prods. Co. [Cl. 206-52.] The holder is also a dispenser, made of board, and provided with a cutter strip.

Warner, Edgar. **Apparatus for coating paper.** U. S. pat. 2,970,564. Filed Dec. 23, 1955. 2 claims. Assigned to The Champion Paper and Fibre Co. [Cl. 118-249.]

Webster, David R. **Liquid dispersion conduit.** U. S. pat. 2,970,644. Filed June 2, 1958. 15 claims. [Cl. 162–338.] An improved stock inlet is provided for a paper machine headbox.

Feb. 14, 1961

Ackley, Edward M., and Pfeiffer, Edward J. **Extensible dolly.** U. S. pat. 2,971,768. Filed Jan. 9, 1959. 5 claims. [Cl. 280-35.] The dolly is for handling stacks of collapsed shipping containers.

Akers, Victor I. **Disposable refuse container.** U. S. pat. 2,971,688. Filed March 11, 1957. 13 claims. [Cl. 229-38.]

Arledter, Hanns F. **Synthetic fiber paper and process for producing the same.** U. S. pat. 2,971,877. Filed March 5, claims. Assigned to Hurlbut Paper Co. [Cl. 162-101.]

Baer, Charles A., Bugbee, Wallace F., Candidus, Edward S., and Clough, Philip J. **Vapor deposition method and apparatus.** U. S. pat. 2,971,862. Filed April 26, 1957. 14 claims. Assigned to National Research Corp. [Cl. 117-61.] A method of aluminizing paper is provided.

Beachler, Edward D., and Goodwillie, John E. **Slice tip mounting.** U. S. pat. 2,971,580. Filed Jan. 29, 1958. 7 claims. Assigned to Beloit Iron Works. [Cl. 162-340.] Accurate control is permitted of the thickness of the throat through which the stock flows onto the forming wire.

Berlyn, Martin J. **Fluid supported web-drying device.** U. S. pat. 2,971,267. Filed July 15, 1957. 11 claims. Assigned to Dominion Eng. Works, Ltd. [Cl. 34-156.] A paper web is dried by passing it through a series of passageways countercurrently to streams of hot air contracting both sides of the web.

Berry, John C., and Newton, George W. **Stocking packaging machine and method.** U. S. pat. 2,971,302. Filed Feb. 12, 1957. 7 claims. Assigned to William J. Berry. [Cl. 53-26.]

Bullock, Austin L., and Guthrie, John D. **Chemically modified textiles.** U. S. pat. 2,971,815. Filed Oct. 31, 1957. 13 claims. Assigned to United States Secretary of Agriculture. [Cl. 8-116.2.] Cellulose is chemically modified so as to obtain a high D.S. while retaining fiber form by cross-linking the cellulose prior to or during the modification.

Canno, Leonard E. **Method of making plastic bags.** U. S. pat. 2,971,874. Filed March 14, 1960. 7 claims. Assigned to Equitable Paper Bag Co., Inc. [Cl. 154-83.] The bas has a separate top compartment and a paperboard reinforcing strip.

Coffey, Henry F. **Article inspection and sorting apparatus.** U. S. pat. 2,971,646. Filed Aug. 17, 1959. 8 claims. Assigned to Eli Lilly and Co. [Cl. 209-111.] Containers are inspected for the presence or absence of a properly positioned label.

Crane, Walton B. **Clip for joining produce containers.** U. S. pat. 2,971,232. Filed July 18, 1958. 1 claim. Assigned to Allied Plastics Co. [Cl. 24-87.] Adjacent paperboard trays are joined together during transit by the clip devices provided.

Doleman, Jack, and Morgan, William V. **Fluidised beds.** U. S. pat. 2,971,242. Filed Feb. 11, 1957. 7 claims. Assigned to Brit. Rayon Research Assoc. [Cl. 26-60.] Improvements are made in an apparatus for drying a woven or nonwoven web by passing it upward through a heated fluidized bed of spherical glass particles.

Engleson, Harry E., and Sramek, Elmer D. **Bag forming and inserting mechanism.** U. S. pat. 2,971,422. Filed Nov. 28, 1955. 6 claims. Assigned to F. B. Redington Co. [Cl. 93-12.] Bags are formed from wax-impregnated material and inserted into paperboard cartons.

Föller, Ernst, and Matlok, Hans. **Packaging machinery for textile ribbons and the like.** U. S. pat. 2,971,244. Filed Sept. 30, 1958. 12 claims. Assigned to Vereinigte Glanzstoff-Fabriken A.G. [Cl. 28-21.] A carton is filled with textile ribbons.

Galbierz, Jerome J. **Dispensing type closure.** U. S. pat. 2,971,681. Filed Jan. 31, 1957. 3 claims. Assigned to R. C. Can Co. [Cl. 222-548.] A plastic pourer-shaker is provided for insertion in the top of a paper can such as that used for packing salt.

Gibbon, James. **Open window envelopes.** U. S. pat. 2,971,689. Filed Nov. 24, 1958. (Divided; original filed March 5, 1958.) 5 claims. Assigned to Kenrick & Jefferson, Ltd. [Cl. 229-71.]

di Giulio, Enzo, and Parrini, Paolo. **Synthetic paper and process for producing same.** U. S. pat. 2,971,858. Filed June 4, 1957. 11 claims. Assigned to Montecatini Societa Generale per l'Industria Mineraria e Chimica. [Cl. 117-12.] This is a nonfibrous polypropylene sheet intended as a substitute for paper.

Gray, Franklin P. **Swivel stacker.** U. S. pat. 2,971,631. Filed Dec. 19, 1958. 16 claims. [Cl. 198-119.] Bags or cartons are received from a conveyor and arranged in stacks.

Griem, Milton E. **Commodity confining and display band.** U. S. Pat. 2,971,641. Filed July 28, 1958. 4 claims. Assigned to Milprit, Inc. [Cl. 206-46.] A windowed paperboard blank is provided for wrapping about a shingled stack of meat or cheese slices held in a transparent wrapper.

Harwood, Kenneth J. **Cellulosic product.** U. S. pat. 2,971,511. Filed Jan. 13, 1958. 2 claims. Assigned to Kimberly-Clark Corp. [Cl. 128-290.] A sanitary napkin is provided.

Hayes, Thomas E. **Money counting machine.** U. S. pat. 2,971,694. Filed Aug. 2, 1957. 4 claims. [Cl. 235-92.] Paper currency is counted.

Heilman, Russel H., Ortmiller, Robert W., and Mueller, Arthur P. **Insulation material and method of making same.** U. S. pat. 2,971,878. Filed Aug. 21, 1953. 20 claims. Assigned to Philip Carey Mfg. Co. [Cl. 162-153.] A heat insulation product is molded from a furnish including perlitic particles, asbestos fibers, and mineral binder.

Hobbins, James F. **Article coiling method and apparatus.** U. S. pat. 2,971,300. Filed Jan. 4, 1957. 21 claims. [Cl. 53-24.] Sanitary napkins are coiled and delivered to a wrapping machine.

Hobbins, James F. **Wrapping method and apparatus, and package produced thereby.** U. S. pat. 2,971,308. Filed Nov. 1, 1956. 1 claim. [Cl. 53-225.] A sanitary napkin is compressed and wrapped.

Hold, Peter. **Calandars.** U. S. pat. 2,971,457. Filed Aug. 13 1958. 5 claims. Assigned to Farrel-Birmingham Co., Inc, [Cl. 100-163.] The roll mountings in a paper machine calender

permit control of nip pressure and uniformity of contact between the rolls.

Hollihan, John P., Jr., Howsmon, John A., and Sisson, Wayne A. **Process of producing viscose rayon.** U. S. pat. 2,971,816. Filed Nov. 3, 1954. 5 claims. Assigned to American Viscose Corp. [Cl. 18-54.] The coagulation modifiers are alkylene oxide adducts of certain amino fatty acyl amides.

Huck, William F. **Scanning device for moving webs.** U. S. pat. 2,971,684. Filed Feb. 28, 1958. 5 claims. Assigned to Huck Co. [Cl. 226-124.]

Johansson, Sven H. **Grinding apparatus for disintegrating fibrous material.** U. S. pat. 2,971,704. Filed Nov. 7, 1955. 1 claim. Assigned to Arne J. A. Asplund. [Cl. 241-37.]

Kindseth, Harold V., and Ludlow, Thomas B. **Pressure sensitive tape.** U. S. pat. 2,971,863. Filed March 11, 1957. 23 claims. Assigned to Bemis Bro. Bag Co. [Cl. 117-68.5.]

Lauring, Edgar A. **Surface decorated fiberboard and method making the same.** U. S. pat. 2,971,856. Filed March 8, 1957. 7 claims. Assigned to Minnesota and Ontario Paper Co. [Cl. 117-10.] A process of coating and decorating hardboard is provided.

Lyon, Floyd A., and Aronson, Theodore F. **Article banding means.** U. S. pat. 2,971,307. Filed Sept. 25, 1958. 4 claims. [Cl. 53-198.] Lengths of tape are heat-sealed about articles such as boxes.

McHan, Thaddus D. **Tomato carton.** U. S. pat. 2,971,639. Filed April 10, 1958. 5 claims. [Cl. 206-45.34.]

Miller, Frank H., Jr. **Apparatus for palletizing.** U. S. pat. 2,971,659. Filed Oct. 29, 1956. 6 claims. Assigned to Miller Eng. Corp. [Cl. 214-6.] Bags or cartons are received and stacked on a pallet.

Miskel, John J., and Wysocki, Kazmier. **Apparatus for loading articles into partitioned cartons.** U. S. pat. 2,971,309. Filed May, 2, 1957. 14 claims. Assigned to Chas. Pfizer & Co., Inc. [Cl. 53-240.]

Mühlhoff, Friedrich. **Container for storing and transporting pourable materials.** U. S. pat. 2,971,686. Filed Nov. 22, 1957. 2 claims. Assigned to Mauser Kommandit-Gesellschaft. [Cl. 229-7.] This container involves a polyethylene container within an outer paperboard carton.

Phillips, Ronald W. **Device for applying punch tags.** U. S. pat. 2,971,306. Filed Aug. 24, 1959. 9 claims. Assigned to St. Lawrence Starch Co., Ltd. [Cl., 53-137.]

Piersol, Jay L. **Water-laid fibrous sheets.** U. S. pat. 2,971,879. Filed Nov. 12, 1957. 9 claims. Assigned to Armstrong Cork Co. [Cl. 162-169.] In the manufacture of paper containing a synthetic rubber binder, zinc oxide is added to the furnish to improve freeness on the wire.

Pihl, Lennart O. **Process for the preparation of an insoluble tobacco sheet or web.** U. S. pat. 2,971,517. Filed June 11, 1959. 5 claims. Assigned to Arenco A.B. [Cl. 131-140.] Carboxymethyl cellulose is used in a binder for tobacco fines.

Roberts, John H. **Lined wirebound box blank.** U. S. pat. 2,971,665. Filed Dec. 31, 1958. 4 claims. Assigned to Vernon E. Ramsey. [Cl. 217-3.] A paper liner including flap is affixed to a flat wirebound box blank.

Silverman, Elsie B. **Portable bookrest.** U. S. pat. 2,971,733. Filed Feb. 14, 1958. 8 claims. [Cl. 248-37.] The bookrest, formed of paper or board, is fixed inside the book cover.

Simjian, Luther G. **Method and apparatus for compartmentizing and storing an article.** U. S. pat. 2,971,303. Filed Dec. 22, 1958. 13 claims. [Cl. 53-28.] Articles are sandwiched between paper tapes and the assembly is coiled.

Sisson, Wayne A., and Thumm, Byron A. **Producing all skin rayon.** U. S. pat. 2,971,817. Filed June 29, 1955. 13 claims. Assigned to American Viscose Corp. [Cl. 18-54.] The coagulation modifier in an alkylene oxide adduct of triethanolamine.

Snelling, Charles D. **Plastic foam packaging.** U. S. pat. 2,971,640. Filed April 7, 1958. 8 claims. [Cl. 206-46.] Fragile articles are protectively held in an outer paperboard carton by a polyurethane foam formed *in situ*.

Striplin, Charles D. **Machine for closing carton lids.** U. S. pat. 2,971,443. Filed Nov. 3, 1958. 2 claims. Assigned to Fibreboard Paper Prods. Corp. [Cl. 93-36.]

Treida, Grover G. **Molded carton for fragile articles.** U. S. pat. 2,971,685. Filed May 3, 1957. 4 claims. Assigned to Kingston Prods. Corp. [Cl. 229-2.5.] An egg carton is molded so as to provide proper support for eggs of various sizes.

Umbriaco, Frank. **Garment bagger.** U. S. pat. 2,971,310. Filed May 25, 1959. 10 claims. [Cl. 53-256.]

Wales, Fred A. **Tea cozy.** U. S. pat. 2,971,687. Filed Oct. 29, 1958. (Divided; original filed April 5, 1954.) 1 claim. [Cl. 229-14.] This is formed of a laminate of water-repellent paper and metal foil.

Webster, Henry. **Grain door.** U. S. pat. 2,971,579. Filed July 15, 1957. 9 claims. [Cl. 160-368.] A railroad car grain door is formed of an assembly of paper and reinforcing elements of hardboard or paperboard.

Webster, Kenneth L., Ball, Walter M., and Coon, Harold R., Sr. **Packaging machine.** U. S. pat. 2,971,305. Filed Sept. 8, 1958. 5 claims. Assigned to Webwraps, Inc. [Cl. 53-59.] Paper wrappers are formed and sealed about popsicles or the like.

Whorton, Robert J. **Carrier.** U. S. pat. 2,971,654. Filed Jan. 29, 1959. 5 claims. [Cl. 211-73.] A carrier for two bottles or the like is designed to be adjusted to hold objects of various diameters.

Feb. 21, 1961

Ashby, William C. **Shot shell packing machine.** U. S. pat. 2,972,217. Filed Feb. 3, 1958. 5 claims. Assigned to Remington Arms Co., Inc. [Cl. 53-374.] An apparatus for closing small cartons is provided.

Austin, William B. **Carbon paper inserting machine.** U. S. pat. 2,972,477. Filed March 21, 1955. 17 claims. [Cl. 270-58.] The machine cuts sheets of carbon paper from a supply roll and arranges them between paper sheets in a stack.

Bramble, Lloyd F. **Asphaltic seal assemblies.** U. S. pat. 2,972,558. Filed Oct. 8, 1956. 12 claims. [Cl. 154-53.5.] A number of layers of asphalt-saturated paper sealed together with asphalt forms a material of use in sealing pipeline joints.

Danielzig, Karl H., and Neuendorf, Gunter. **Packing apparatus.** U. S. pat. 2,972,215. Filed June 13, 1958. 10 claims. Assigned to Firma Habra-Werk Wilhelm F. Ott. [Cl. 53-195.] A series of interconnected flat open-top containers are formed in one web of paper, and another web is sealed over the containers as a closure.

Dubbs, Wendell P. **Tape applicator.** U. S. pat. 2,972,428. Filed Jan. 19, 1959. 11 claims. Assigned to Cellotape & Tag Printers. [Cl. 216-25.] Lengths of pressure-sensitive tape are drawn from a supply roll, severed, and applied to a package.

Early, Harold C., and Miller, David B. **Method of drying printed webs.** U. S. pat. 2,972,196. Filed July 22, 1957. 7 claims. Assigned to Meredith Publishing Co. [Cl. 34-1.]

Eaton, Gerald L. **Pyrolysis of waste sulfite liquor.** U. S. pat. 2,972,520. Filed Sept. 6, 1957. 8 claims. Assigned to United Engineers & Constructors, Inc. [Cl. 23-209.4.]

Flack, Alfred, and Ludder, Rodney. **Flexible thermoplastic nestable closure lids.** U. S. pat. 2,972,432. Filed Feb. 27, 1958. 6 claims. Assigned to Lily-Tulip Cup Corp. [Cl. 220-60.] Improved plastic lids are provided for containers of the round nesting paper type.

Hartman, Robert, J., and Fujiwara, Edward J. **Catalytic aminoethylation of cellulose, cellulose derivatives or polyvinyl alcohol.** U. S. pat. 2,972,606. Filed May 31, 1956. 8 claims. Assigned to Wyandotte Chems. Corp. [Cl. 260-91.3.]

Heritage, Clark C. **Production of wood fiber.** U. S. pat. 2,972,171. Filed Oct. 4, 1952. 9 claims. Assigned 50% to Weyerhaeuser Co. and 50% to Wood Conversion Co. [Cl. 19-72.] A method is provided for fractionating and moving defibered wood while the wood fibers are entrained in a steam vehicle.

Hogle, Donald H. **Purification of cyanoethylcellulose resin.** U. S. pat. 2,972,609. Filed Dec. 20, 1957. 3 claims. Assigned to Westinghouse Elec. Corp. [Cl. 260-232.]

Jensen, Thormod. **Cooling method and means for laminating web materials.** U. S. pat. 2,972,369. Filed Oct. 1, 1956. 5 claims. Assigned to St. Regis Paper Co. [Cl. 154-1.6.] An improved method is provided for laminating paper to cellophane in the preparation of a bread wrap.

Konold, J. Reyonolds. **Heat transfer roll.** U. S. pat. 2,972,472. Filed June 11, 1956. 4 claims. Assigned to Armstrong Cork Co. [Cl. 257-95.] An improved heat transfer or calender roll is provided for working linoleum or the like.

Knoche, Raymond E. **Apparatus for feeding looseleaf metal arches.** U. S. pat. 2,972,433. Filed Nov. 5, 1958. (Divided; original filed Sept 5, 1951.) 5 claims. [Cl. 221-160.] Looseleaf metal arches or binder ring elements are fed to a machine for fixing them onto a backing strip.

Mayer, Ben. **Container with mixing attachment.** U. S. pat. 2,972,406. Filed Oct. 14, 1957. 6 claims. [Cl. 206-47.] A paper cup is constructed with a cover and handle attachment for use as a stirring device.

Mitchell, Arthur B. **Sheet gripper for printing presses.** U. S. pat. 2,972,300. Filed April 23, 1959. 3 claims. Assigned to Miehle-Goss-Dexter, Inc. [Cl. 101-412.]

Munroe, Thomas. **Refrigerator crate.** U. S. pat. 2,972,440. Filed Oct. 30, 1957. 4 claims. Assigned to Moraine Box Co. [Cl. 229-23.] A collapsible crate for heavy articles is formed of corrugated board with wooden reinforcing elements.

Muskat, Irving E., and Klein, Joseph J. **Pad and method of making same.** U. S. pat. 2,972,554. Filed May 23, 1955. 9 claims. Assigned to Fiber Bond Corp. [Cl. 117-76.] A nonwoven fibrous mat impregnated with a foamed polyvinyl chloride composition, foamed *in situ*, forms an insulating or cushioning material.

Nuyens, Augustinus F. H. J. M. **Treatment by compression of fibro-cement wet sheet material and the like.** U. S. pat. 2,972,378. Filed June 20, 1956. 3 claims. [Cl. 162-361.] An apparatus is provided for compressing the wet fibrous sheet

formed by a board machine in making paperboard of asbestos-cement products.

Stilbert, Elmer K., Zembal, Marion W., and Silvernail, Lloyd H. **Method of manufacturing paper.** U. S. pat. 2,972,560. Filed April 13, 1955. 4 claims. Assigned to The Dow Chemical Co. [Cl. 162-168.] Filler retention is improved by adding a polyacrylamide to the furnish.

Thurnher, Ferdinand. **Art of feeding mats to a hot-press.** U. S. pat. 2,972,423. Filed April 15, 1957. 23 claims. Assigned to Washington Iron Works. [Cl. 214-16.4] Hardboard mats are charged into a hot press without using caul plates.

Upton, George, Jr. **Abrasive product and method of making.** U. S. pat. 2,972,527. Filed March 3, 1959. 8 claims. Assigned to Chem. Research Corp. [Cl. 51-298.] A paper backing has a coating of a foamed resin with abrasive grains embedded in the resin.

Wilke, Werner, and Fetzer, Hans. **Method of converting individual fibers into coherent fibrous bodies.** U. S. pat. 2,972,221. Filed July 26, 1957. 16 claims. Assigned to Rex Asbestwerke Graf von Rex K.G. [Cl. 57-164.] Shaped bodies such as sheets and tubes are formed from an aqueous dispersion of fibers such as asbestos fibers.

Feb. 28, 1961

Berry, Elmer H. **Holster carton.** U. S. pat. 2,973,091. Filed Jan. 11, 1960. 4 claims. Assigned to The New Haven Board & Carton Co. [Cl. 206-79.] A toy revolver is packaged on a card so that the completed pack resembles a holstered revolver.

Biel, Hans, and Pfäffle, Ernst. **Machine for manufacturing pads bound with a spiral wire.** U. S. pat. 2,973,199. Filed May 19, 1958. 6 claims. [Cl. 270-1.]

Brichard, Edgard, Plumat, Emile, and Leger, Lucien. **Process for the protection of glass against iridescence and package for carrying this process into effect.** U. S. pat. 2,973,089. Filed May 8, 1957. 10 claims. Assigned to Union des Verreries Mecaniques Belges, Societe Anonyme. [Cl. 206-62.] Wrapping paper impregnated with sodium bisulfate is used.

Cottrill, Charles E. **Separable plural carton and blank there for.** U. S. pat. 2,973,130. Filed April 24, 1957. 2 claims. Assigned to Standard Pkg. Corp. [Cl. 229-51.]

Cronquist, Norman W., and Mohler, Donald. **Electrolytic capacitor.** U. S. pat. 2,973,465. Filed Dec. 1, 1959. 3 claims. Assigned to the United States of America as represented by the Secretary of the Army. [Cl. 317-230.] Paper is used as dielectric material.

Du Broff, Warren. **Apparatus for perimetric taping.** U. S. pat. 2,972,843. Filed Oct. 30, 1958. 18 claims. Assigned to Charles Barancik. [Cl. 53-74.] The device tapes together a number of cartons arranged in a stack.

Ferens, Marcella. **Hair curlers.** U. S. pat. 2,972,994. Filed April 22, 1957. 3 claims. [Cl. 132-40.] The curler comprises a sheet of parchment attached along the length of a paper tube.

Gentry, Hermond G. **Means for feeding paperboard blanks.** U. S. pat. 2,973,201. Filed Sept. 10, 1959. 9 claims. Assigned to The Mead Corp. [Cl. 271-12.]

Hildebrandt, Friedrich. **Method of shredding and aging alkali-cellulose.** U. S. pat. 2,973,352. Filed June 26, 1956. 4 claims. Assigned to Spinnfaser G. [Cl. 260-233.]

Hitchcock, Eugene B. **Can packaging method and machine.** U. S. pat. 2,972,842. Filed Oct. 12, 1956. 11 claims. [Cl. 53-55.] Six small cans of frozen fruit juice are packed in a preglued collapsible open-end carton.

Leone, Salvatore J. **Carton connector.** U. S. pat. 2,973,128. Filed June 14, 1960. 5 claims. Assigned to The New Haven Board & Carton Co. [Cl. 229-15.] A paperboard device is provided for joining two cartons together to make up a merchandising deal.

Owens, Robert S. **Method of recovering cork-like material from birch tree bark.** U. S. pat. 2,973,152. Filed July 24, 1958. 11 claims. [Cl. 241-28.]

Parker, Brooks O'C. **Portable container for liquids.** U. S. pat. 2,973,119. Filed April 15, 1957. 14 claims. [Cl. 222-131.] The container includes an outer carton and an inner plastic bag.

Pearson, Robert L. **Consistency responsive device.** U. S. pat. 2,973,000. Filed Jan. 31, 1956. 2 claims. Assigned to Riegel Paper Corp. [Cl. 137-91.] This is a stock consistency controller.

Rich, John P. **Pulper.** U. S. pat. 2,973,153. Filed May 16, 1958. 4 claims. Assigned to Improved Machinery, Inc. [Cl. 241-46.] A beater which may be operated under high pressure is provided for use in a continuous pulping system.

Rodgers, Ellis J., Jr. **Process of incorporating foamable materials in corrugated paperboard and the article derived therefrom.** U. S. pat. 2,973,295. Filed May 8, 1957. 2 claims. Assigned to Crown Zellerbach Corp. [Cl. 154-100.] A polyurethane foam is formed *in situ* within the flutes of corrugated board.

Rohdin, Howard A. **Easy opening blister pack.** U. S. pat. 2,973,087. Filed June 23, 1958. 1 claim. [Cl. 206-56.]

Royce, Mark B. **Container for packaging apples.** U. S. pat. 2,973,127. Filed Jan. 13, 1960. 4 claims. Assigned to Continental Can Co., Inc. [Cl. 229-6.]

Schmeck, Robert E., and Conklin, Joseph P. **Document feeding control means.** U. S. pat. 2,973,202. Filed Sept. 29, 1958. 13 claims. Assigned to Pitney-Bowes, Inc. [Cl. 271-57.] Various improvements are made in an apparatus for feeding checks to a processing machine.

Semegen, Stephen T. **Leather-like material.** U. S. pat. 2,973,284. Filed April 30, 1957. 7 claims. Assigned to The B. F. Goodrich Co. [Cl. 117-76.] This is a nonwoven fibrous felt impregnated with an elastic butadiene copolymer and with a polyesterurethane.

Stone, Orison W., and Campbell, Laurie H. **Dual locking construction for paperboard wrappers.** U. S. pat. 2,973,129. Filed Nov. 14, 1957. 1 claim. Assigned to Continental Can Co., Inc. [Cl. 229-16.] Improved interlocking devices are provided in a six-pack can carton of the wrap-around type.

Thompson, Joseph. **Cartons.** U. S. pat. 2,973,086. Filed June 18, 1958. 2 claims. Assigned to Coates Board & Carton Co., Inc. [Cl. 206-45.31.] Portions of the carton walls are torn away and folded back to reveal a display window.

Ulrich, Erwin W. **Solvent-resistant pressure-sensitive polyacrylic adhesive tape and method of preparing same.** U. S. pat. 2,973,286. Filed March 30, 1956. 6 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 117-122.] The backing may be of paper.

Van Hoof, Albert E. **Light-sensitive photographic paper.** U. S. pat. 2,973,262. Filed June 18, 1957. 4 claims. Assigned to Gevaert Photo-Producten N.V. [Cl. 96-85.]

White, William A., Jr. **Paper machinery.** U. S. pat. 2,973,034. Filed March 3, 1958. 9 claims. Assigned to The Black-Clawson Co. (Cl. 162-339.] The headbox includes rectifier rolls the restricting action of which may be varied.

Weiner, Jerome B., Stern, Hans M., and Nelson, Alfred M. **Card processing apparatus.** U. S. pat. 2,973,200. Filed Dec. 23, 1957. 27 claims. Assigned to Magnavox Co. [Cl. 271-5.] Improved card-feeding means are provided in a machine for processing data cards.

Zernov, Peter. **Cut-off knife assembly for continuous rewinders.** U. S. pat. 2,973, 158. Filed 19, 1958. 1 claim. Assigned to Mercury Eng. Corp. [Cl. 242-56.]

Zernov, Peter. **Expandable mandrel for web rewinders.** U. S. pat. 2,973,160. Filed Jan. 26, 1959. 2 claims. Assigned to Mercury Eng. Corp. [Cl. 242-72.]

March 7, 1961

Adams, George M. **Printed plastic films.** U. S. pat. 2,974,057. Filed June 10, 1959. 8 claims. Assigned to Union Carbide Corp. [Cl. 117-12.] Cellulose derivatives are used in formulating a coating for polyvinyl chloride film.

Apel, Alfons. **Hydrolysis of vegetable cellulosic materials.** U. S. pat. 2,974,067. Filed Feb. 11, 1958. 3 claims. Assigned to Udic Societe Anonyme. [Cl. 127-37.]

Biggs, William A., Jr., and Robertson, Julius D. **Method for integrating sodium based sulfite and sulfate pulping processes.** U. S. pat. 2,974,081. Filed May 19, 1955. 4 claims. Assigned to Sonoco Prods. Co. [Cl. 162-33.]

Bonaldi, Giacomo M. **Form to be used with garment hanger.** U. S. pat. 2,973,887. Filed July 15, 1958. 2 claims. [Cl. 223-88.] A paperboard blank attaches to a garment hanger to support the collar of a garment placed thereon.

Brainard, Carl W., and Brainard, Helen V. **Disposable garment.** U. S. pat. 2,973,523. Filed Oct. 20, 1958. 1 claim. [Cl. 2-46.] The garment, for children, handicapped adults, etc., is formed of soft tissue having its outer surface treated to provide moisture repellency.

Burden, Edward R. **Self-locking folding box.** U. S. pat. Re. 24,946. Filed July 8, 1959. (Divided; original filed Aug. 5, 1958.) 7 claims. [Cl. 229-34.]

Busch, Richard E. **Anti-jamming device for feeding paper.** U. S. pat. 2,973,957. Filed July 7, 1958. 1 claim. Assigned to Clary Corp. [Cl. 226-198.]

Carlin, Raymond W., and McKinney, James C. **Liner type box wrap package.** U. S. pat. 2,973,893. Filed Dec. 10, 1958. 1 claim. Assigned to Procter & Gamble Co. [Cl. 229-40.] This is a package for a bar of soap which simulates an overwrapped carton.

Casey, Charles L., and Ryno, Juddson B. **Paper toweling dispenser.** U. S. pat. 2,973,958. Filed July 28, 1955. 5 claims. Assigned to Reliable Eng. Co. [Cl. 226-130.] This is a wall-mounted dispensing device.

Cohen, Manuel. **One-piece platform type article holder for packages.** U. S. pat. 2,973,860. Filed April 21, 1958. 10 claims. Assigned to Wagner Folding Box Corp. [Cl. 206-79.] The platform supports pastry items or the like in an outer bag or carton.

Dudley, Elizabeth. **Sanitary napkin.** U. S. pat. 2,973,760. Filed June 30, 1958. 2 claims. Assigned to Scott Paper Co. [Cl. 128-287.]

Duerr, Herman H. **Process of modifying the composition of the surface of a layer of plastic material.** U. S. pat. 2,974,061. Filed March 17, 1958. 10 claims. Assigned to General Aniline & Film Corp. [Cl. 117-62.] A film-casting surface made of a cellulose ester is provided.

Engleson, Harry E., and Sramek, Elmer D. **Packaging machine.** U. S. pat. 2,973,611. Filed April 7, 1958. (Divided; original filed March 13, 1957.) 10 claims. Assigned to F. B. Redington Co. [Cl. 53-266.] Stacks of nested paper cups moving along one conveyor are transferred into cartons being carried along on a second conveyor.

Hedrick, Glen W. **Mercerizing compositions containing pinonic acid.** U. S. pat. 2,974,002. Filed June 30, 1959. 1 claim. Assigned to U. S. Secretary of Agriculture. [Cl. 8-125.]

Heuer, Kurt, McPeters, Arnold L., and Knight, Albin F. **Manufacture of rayon.** U. S. pat. 2,974,005. Filed June 2, 1958. 7 claims. Assigned to American Enka Corp. [Cl. 18-54.] High tenacity fatigue resistant rayon is produced.

Killion, John F. **High-speed system for feeding and sealing cartons.** U. S. pat. 2,973,608. Filed Sept. 4, 1957. 28 claims. Assigned to Food Machinery and Chem. Corp. [Cl. 53-38.]

Krueger, Alfred P. **Tape-dispensing mechanism.** U. S. pat. 2,973,890. Filed May 1, 1959. 6 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 225-43.] This is a device for dispensing lengths of pressure-sensitive tape from a supply roll.

Laneve, Arthur L., Nash, Harold E., and Tress, Richard L. **Container for wire, tubing, cordage and the like.** U. S. pat. 2,973,858. Filed March 13, 1958. 5 claims. Assigned to Crown Zellerbach Corp. [Cl. 206-52.] This is a flat carton formed from a single blank for holding coiled materials.

McGowan, William S. **Bag opener.** U. S. pat. 2,973,612. Filed Feb. 20, 1956. 18 claims. [Cl. 53-384.] Bags are fed, opened, and held for filling.

Mosier, William H. **Method and apparatus for packaging fibrous materials.** U. S. pat, 2,973,607. Filed July 18, 1956. (Divided; original filed June 8 1950.) 4 claims. Assigned to Owens-Corning Fiberglas Corp. [Cl.5 3-24.] Mats of glass fibers or the like are compressed and packaged in paper.

Oldenboom, Derk J. **Sheet feeding devices.** U. S. pat. 2,973,709. Filed May 14, 1957. (Divided; original filed July 22, 1953.) 4 claims. Assigned to Intern. Business Machines Corp. [Cl. 101-287.] Means for feeding sheets and envelopes to a printing station are designed to handle a variety of sizes and thicknesses of materials.

Orlando, Matthew. **Battery lining mechanism.** U. S. pat. 2,973,698. Filed Nov. 29, 1957. 18 claims. Assigned to Matthew Orlando. [Cl. 93-36.01.] A flat sheet of paper is formed into a tube and inserted into a can, as in lining a cylindrical dry cell.

Pihl, Lennart. **Method of applying a layer of printing ink plus an additional layer of an underlay.** U. S. pat. 2,974,058. Filed Oct. 10, 1958. 6 claims. Assigned to Research AB. [Cl. 117-15.] A method of printing on paper or board is provided.

Powell, Walter G. **Band-tie.** U. S. pat. 2,973,597. Filed Dec. 10, 1956. 2 claims. Assigned to Band-Ti Mfg. Co. [Cl. 40-21.] Two strips of paper laminated with a wire strand therebetween form a material of use in banding and marking articles.

Powell, Walter G. **Machine for and method of making band-ties.** U. S. pat. 2,973,798. Filed Dec. 10, 1956. 24 claims. Assigned to Band-Ti Mfg. Co. [Cl. 154-1.6.] These packaging ties comprise wire and marking tabs glued between strips of paper.

Randall, Ralph S. **Bag filling machine.** U. S. pat. 2,973,610. Filed June 27, 1958. 18 claims. [Cl. 53-188.] A stack of meat slices is inserted into a bag which is then sealed.

Richer, Irving. **Garment box.** U. S. pat. 2,973,857. Filed Feb. 13, 1959. 3 claims. [Cl. 206-7.] The flat carton holds the garment neatly without the aid of a hanger.

Scheuer, Seymour. **Tearing device for toilet tissue holder.** U. S. pat. 2,973,891. Filed Dec. 23, 1957. 5 claims. [Cl. 225-89.]

Schladermundt, Peter, Dennerlein, William H., and Simons, Langdon S., Jr. **Adhesive bandage.** U. S. pat. 2,973,859. Filed April 20, 1959. 16 claims. Assigned to Johnson & Johnson. [Cl. 206-63.2.] In a band-aid type bandage, the paper protective strips form part of the outer wrapper.

Schmidt, Hans R., and Wiesner, Max. **Sheet film pack for x-ray photographic purposes.** U. S. pat. 2,974,229. Filed Aug. 26, 1958. 4 claims. Assigned To Agfa AG. [Cl. 250-69.]

Süs, Oskar, and Glos, Martin. **Diazotype reproduction process.** U. S. pat. 2,974,042. Filed June 19, 1957. 13 claims. Assigned to Keuffel & Esser Co. [Cl. 96-49.] A diazotype paper is described.

Sylvester, John D. **Apparatus for maintaining the orientation of stacked bags.** U. S. pat. 2,973,797. Filed Jan. 28, 1960. 3 claims. Assigned to Amsco Pkg. Machinery, Inc. [Cl. 154-1.] A heated piercing tool is passed through heat-sealable bags in a stack to temporarily hold the stack together.

Thumim, Carl. **Safety pull bar for paper cutting machines.** U. S. pat. 2,973,852. Filed July 2, 1957. 1 claim. Assigned to Miehle-Goss-Dexter, Inc. [Cl. 192-150.]

Aaron, Charles. **Apparatus for controlling tension in a running web.** U. S. pat. 2,974,893. Filed Nov. 19, 1956. 2 claims. Assigned to Cameron Machine Co. [Cl. 242-74.43.]

March 14, 1961

Aaron, Charles. **Apparatus for controlling tension in a running web.** U. S. pat. 2,974,893. Filed Nov. 19, 1956. 2 claims. Assigned to Cameron Machine Co. [Cl. 242-75.43.]

Aaron, Charles. **Apparatus for counteracting tension variations localized toward either side of a running web.** U. S. pat. 2,974,894. Filed June 12, 1958. 2 claims. Assigned to Cameron Machine Co. [Cl. 242-75.43.]

Abbott, Corliss W., and Freeman, Howard I. **Composition comprising polyester, protective colloid and clay and paper coated therewith.** U. S. pat. 2,975,147. Filed May 5, 1958. 9 claims. Assigned to The Sherwin-Williams Co. [Cl. 260-7.5.]

Allison, William M. **Electrical capacitors.** U. S. pat. 2,974,396. Filed Jan. 18, 1957. 5 claims. A capacitor is formed of interwound layers of foil and dielectric material.

Anderson, William E. **Laminated paper.** U. S. pat. 2,975,904. Filed Feb. 18, 1957. 2 claims. Assigned to Riegel Paper Corp. [Cl. 154-138.] Two layers of paraffin-laminated and coated sulfite paper form a moistureproof packaging paper.

André, Noble, Fahrenbach, Wolfgang B., and Tyll, John J. **Can packaging apparatus and method.** U. S. pat. 2,974,454. Filed March 22, 1956. 8 claims. Assigned to Andre-Matic Machinery Co. [Cl. 53-32.] A wrap-around blank is applied about a group of cans to form an open-end six-pack.

Baird, William G., Jr. **Copies and method for making the same.** U. S. pat. 2,974,370. Filed Jan. 14, 1959. 20 claims. Assigned to W. R. Grace & Co. [Cl. 18-47.5.] The copy sheet is made of plastic and is shrunk by heat after having indicia placed thereon.

Batlas, George X., and Baranski, Stephen. **Dispensers for paper toweling.** U. S. pat. 2,974,839. Filed July 16, 1958. 19 claims. [Cl. 225-12.]

Belsinger, Samuel P. **Wardrobe.** U. S. pat. 2,974,779. Filed April 29, 1957. 22 claims. [Cl. 206-7.] A paperboard shipping container for hangered garments is constructed to prevent slippage of the hangers.

Boehmer, Floyd O. **Shirt reinforcing member.** U. S. pat. 2,974,837. Filed Nov. 23, 1959. 9 claims. Assigned to A. & C. Boehmer, Ltd. [Cl. 223-71.] This article is formed of paperboard.

Britt, Edward C. **Packaging means for articles.** U. S. pat. 2,974,784. Filed March 1, 1960. 4 claims. Assigned to Ruspak Corp. [Cl. 206-47]. An outer paper envelope with inner film enclosure is used as a package for optical spectacle frames.

Cranford, William B., and Major, Frederick W. **Bleaching of cellulose pulp.** U. S. pat. 2,975,169. Filed Aug. 22, 1957. 7 claims. Assigned to Canadian Intern. Paper Co. [Cl. 260-212.]

Demler, Ray C. **Carton packaging machine for sheets.** U. S. pat. 2,974,461. Filed Oct. 7, 1957. 9 claims. Assigned to Intern. Pkg. Corp. [Cl. 53-388.] Sheets of hardboard or wallboard are packed in a carton.

Fielding, Francis W. **Carton.** U. S. pat, 2,974,848. Filed Feb. 1, 1960. 6 claims. Assigned to Lengsfield Bros., Inc. [Cl. 229-27.] A sleeve-type carton is designed to hold two cans of different size to make up a merchandising unit.

Fienup, Wilbur G., and Erdie, John Sr. **Dough package.** U. S. pat. 2,975,068. Filed May 26, 1958. 6 claims. Assigned to RC Can Co. [Cl. 99-172.] The cylindrical container includes a wound paperboard body, a foil-paper inner liner, and an outer wrap-around label.

Foote, James E., and Snow, Carl A. **Stock meter.** U. S. pat. 2,974,834. Filed Sept. 15, 1959. 8 claims. Assigned to Diamond Natl. Corp. [Cl. 222-356.] The meter is of use in supplying high-consistency stock to a pulp molding machine.

Fourness, Charles Albert. **Corrugated packaging material.** U. S. pat. 2,974,716. Filed June 25, 1957. 10 claims. Assigned to Kimberly-Clark Corp. [Cl. 154-31.] The material is flexible in all directions, so that it may be shaped about an article being wrapped.

Gibson, Dora S. **Greeting card.** U. S. pat. 2,974,434. Filed Jan. 4, 1960. 1 claim. Assigned to Hallmark Cards, Inc. [Cl. 40-124.1.] A greeting card contains a three-dimensional paper unit which unfolds when the card is opened.

Ginaven, Marvin E., and Adams, Albert H. **Impregnation of wood chips.** U. S. pat. 2,975,096. Filed Nov. 18, 1957. 12 claims. Assigned to The Bauer Bros. Co. [Cl. 162-18.] A modified screw press is used to impregnate wood chips with cooking liquor.

Ginaven, Marvin E., and Woodruff, Maurice D. **Reinforced molded cone.** U. S. pat. 2,974,684. Filed Nov. 25, 1955. 2 claims. Assigned to The Bauer Bros. Co. [Cl. 138-64.] A plastic liner is molded within the metal base of a centrifugal cleaner.

Griffeth, Forrest P., and Griffeth, Lena. **Combined closure and scouring pad for containers.** U. S. pat. 2,974,786. Filed April 25, 1958. 4 claims. [Cl. 206-47.] A cylindrical container for scouring powder is closed with a circular pad of absorbent cellulosic material fastened across the top of the container.

Howsmon, John A. **Producing all skin viscose rayon.** U. S. pat. 2,975,019. Filed Nov. 3, 1954. 12 claims. Assigned to American Viscose Corp. [Cl. 18-54.] The coagulation modifiers are alkylene oxide adducts of lactams.

Hurn, Basil A., and Rudd, Gerald A. **Packages or cartons for eggs and other fragile articles.** U. S. pat. 2,974, 847. Filed Sept. 17, 1958. 7 claims. Assigned to Diamond Natl. Corp. [Cl. 229-2.5.] A molded pulp egg carton is provided.

Huss, William S., and Kuchenbecker, Morris W. **Dispensing carton.** U. S. pat. 2,974,852. Filed June 24, 1957. 2 claims. Assigned to American Can Co. [Cl. 229-51.] An improved dispensing opening is provided in the top of a carton of the type used for packing facial tissues.

Jankens, Austin L., and Hoerger, Fred D. **Resin coated paper.** U. S. pat. 2,975,074. Filed Feb. 14, 1957. 16 claims. Assigned to The Dow Chem. Co. [Cl. 117-76.] A packaging paper of low water vapor and gas permeability is provided.

Jung, Johannes. **Centrifugal-type pulp separator.** U. S. pat. 2,974,796. Filed Sept. 4, 1957. 5 claims. [Cl. 209-284.]

Kearton, Christoper F., Givens, John H., and Aldred, Fred C. **Preparation of wood pulp.** U. S. pat. 2,974,420. Filed Aug. 27, 1957. 3 claims. Assigned to Courtaulds, Ltd. [Cl. 34-10.] Particles of pulp are dried in a fluidized bed.

Keydel, Kurt R. **Dust mop.** U. S. pat. 2,974,339. Filed April 25, 1958. 7 claims. Assigned to Key Prods. Co. [Cl. 15-229.] A dust mot head is made of oil-impregnated strips of paper.

Kinney, Alfred W. **Lid capping device.** U. S. pat. 2,974,459. Filed June 9, 1959. 6 claims. Assigned to American Can Co. [Cl. 53-342.] An aluminum foil closure disk is crimped about the edge bead on a paper cup.

Lane, Dan R. **Packaging support.** U. S. pat. 2,974,844. Filed Feb. 15, 1960. 10 claims. Assigned to Lane Container Co. [Cl. 229-14.] A pad of several plies of corrugated is used as an interior packing member for use in packaging fragile articles.

Levkoff, David. **Bottle carriers.** U. S. pat. 2,974,827. Filed Aug. 23, 1957. 1 claim. Assigned 25% each to Evelyn S. Levkoff, Henry S. Levkoff, and Edith L. Sennet. [Cl. 220-113.]

Matteson, Russell E. **Vertical chute dispenser.** U. S. pat. 2,974,828. Filed April 16, 1958. 8 claims. Assigned to Diamond Natl. Corp. [Cl. 221-221.] Means are provided to remove a molded pulp egg carton from a nested stack and prepare it for filling.

Mayer, Louis. **Combined shipping container and dispensing receptacle.** U. S. pat. 2,974,850. Filed May 10, 1954. 3 claims. Assigned to Owens-Illinois Glass Co. [Cl. 229-37.] The container, formed of paperboard, is for coiled material such as rope or wire.

Moore, Marion F. **Reclosable carton.** U. S. pat. 2,974,874. Filed June 17, 1957. 1 claim. Assigned to Container Corp. of Am. [Cl. 229-87.] A display carton having a windowed hinged lid is provided for packing food products, garments, or the like.

Muskat, Louis R., Klopfenstein, King L., and Kleboe, John E. **Wrapping apparatus and method.** U. S. pat. 2,974,458. Filed June 29, 1959. 12 claims. Assigned to Triangle Package Machinery Co. [Cl. 53-206.] A wrapper is applied in diamond-wrap configuration about a tray.

Newman, Douglas A. **Duplicating.** U. S. pat. 2,974,585. Filed July 7, 1958. 5 claims. Assigned to Columbia Ribbon and Carbon Mfg. Co. [Cl. 101-149.4.] A composite assembly of pressure-responsive sheet elements is provided for preparing a duplicating master.

Okawa, Risaku, and Okawa, Riichiro. **Cylinder machine for forming a web in paper making.** U. S. pat. 2,974,726. Filed April 15, 1958. 2 claims. [Cl. 162-328.]

Park, Robert W. **Method of laminating cellulose films.** U. S. pat. 2,975,093. Filed Dec. 16, 1958. 10 claims. Assigned to American Viscose Corp. [Cl. 154-136.]

Pasquinelli, Bruno B., and Peyrebrune, Henri E. **Sheet feeding mechanism.** U. S. pat. 2,974,950. Filed July 1, 1959. 12 claims. Assigned to Miehle-Goss-Dexter, Inc. [Cl. 271-44.] Sheets of paperboard are fed from the bottom of a supply stack to a carton machine or the like.

Peistrup, Henry F. **Wrapping.** U. S. pat. 2,975,090. Filed April 16, 1956. 2 claims. Assigned to Bemis Bro. Bab Co. [Cl. 154-50.] Carpeting is wrapped in a material comprising asphalt-laminated paper and burlap.

Reifers, Richard F. **Egg carton.** U. S. pat. 2,974,842. Filed May 13, 1958. 11 claims. Assigned to Diamond Natl. Corp. [Cl. 229-2.5.] An egg carton has a molded pulp bottom section and a transparent top.

Reifers, Richard F., and Wells, Roger. **Food container.** U. S. pat. 2,974,843. Filed July 23, 1958. 18 claims. Assigned to Diamond Natl. Corp. [Cl. 229-2.5.] A molded pulp tray for packaging meat products is provided.

Robbons, Gerald L. **Molded pulp packing for bottles.** U. S. pat. 2,974,788. Filed Sept. 25, 1957. 4 claims. Assigned to Keyes Fibre Co. [Cl. 206-65.]

Schmidt, Maximilian P., and Süs, Oskar. **Reproduction material.** U. S. pat. 2,975,053. Filed Oct. 6, 1958. 20 claims. Assigned to Azoplate Corp. [Cl. 96-33.] A diazotype paper is provided.

Shields, Albert F. **Cutting and creasing press with movable stops.** U. S. pat. 2,974,572. Filed Aug. 4, 1958. (Divided; original filed June 15, 1954.) 24 claims. Assigned to S & S Corrugated Paper Machinery Co., Inc. [Cl. 93-58.3.]

Simpson, Donald D. **Packing dividers.** U. S. pat. 2,974,817. Filed Aug. 1, 1958. 3 claims. Assigned to ACF Inds., Inc. [Cl. 217-31.] Interlockable carton-partitioning strips are provided.

Sisson, Wayne A. **Method of producing viscose rayon.** U. S. pat 2,975,021. Filed Nov. 3, 1954. 12 claims. Assigned to American Viscose Corp. [Cl. 18-54.] The coagulation modifier is an alkylene oxide adduct of urea or biuret.

Struble, Glenn E. **Carton having pour spout with reclosure.** U. S. pat 2,974,845. Filed May 19, 1959. 4 claims. Assigned to Diamond Natl. Corp. [Cl. 229-17.]

Struble, Glenn E. **Carton with reclosing pour spout.** U. S. pat. 2,974,846. Filed May 19, 1959. 12 claims. Assigned to Diamond Natl. Corp. [Cl. 229-17.]

Struble, Glenn E. **Cartons.** U. S. pat. 2,974,851. Filed Dec. 2, 1957. 4 claims. Assigned to Diamond Natl. Corp. [Cl. 229-40.] A sleevelike carton for unitizing a number of glass jars or the like is provided.

Struble, Glenn E. **Easily opened and reclosed carton.** U. S. pat. 2,974,853. Filed July 22, 1959. 8 claims. Assigned to Diamond Natl. Corp. [Cl. 229-51.]

Swanson, Veron E. **Hand set-up carton.** U. S. pat. 2,974,849. Filed March 24, 1959. 14 claims. Assigned to Diamond Natl. Corp. [Cl. 229-28.] A partitioned egg carton is designed to be erected from collapsed condition by hand.

Tallis, Ernest E., and Tyler, David N. **Production of regenerated cellulose filaments.** U. S. pat. 2,975,023. Filed June 23, 1958. 11 claims. Assigned to Courtaulds, Ltd. [Cl. 18-54.] High tenacity all-skin rayon filaments are produced.

Thompson, Harry G. **Device for dewaxing carton conveyors.** U. S. pat. 2,974,631. Filed June 2, 1958. 4 claims. [Cl. 118-70.]

Thumm, Byron A. **Producing all skin viscose rayon.** U. S. pat. 2,975,020. Filed Nov. 3, 1954. 8 claims. Assigned to American Viscose Corp. [Cl. 18-54.] The coagulation modifier is a water-soluble aklylene oxide adduct of aniline.

Tobey, Frederick S. **Heat-resistant adhesive article.** U. S. pat. 2,975,091. Filed July 21, 1955. 1 claim. Assigned to W. H. Brady Co. [Cl. 154-53.5.] A paper label which adheres under high temperature is provided.

Trotter, Wilson D. **Stocking package.** U. S. pat. 2,974,783. Filed March 21, 1958. 3 claims. [Cl. 206-46.] A paperboard device is provided for supporting knee-length hosiery in forming a package thereof.

Van Blaricom, Lloyd E., and Tokos, George M. **Process for forming a chemical product from bark.** U. S. pat. 2,975,126. Filed Feb. 11, 1958. 12 claims. Assigned to Rayonier, Inc. [Cl. 252-8.5.]

van Leer, Oscar J. **Shipping container.** U. S. pat. 2,974,841 Filed April 20, 1959. 6 claims. Assigned to Grotnes Machine Works, Inc. [Cl. 229-1.5.] A shipping container formed of paper or the like, designed to replace the 55-gal. drum, is constructed so that the containers may be placed side-by-side in nested relation.

Vogt, Clarence W. **Method for forming and filling packages.** U. S. pat. 2,974,452. Filed July 23, 1956. 5 claims. [Cl. 53-24.] Commodities such as flour or gelatinous materials are packaged in paperboard-reinforced film packs.

Walters, Edgar H. **Special packages for toy balloons and like articles.** U. S. pat. 2,974,782. Filed Nov. 2, 1959. 5 claims. [Cl. 206-45.33.] This is a display carton with an inner paperboard device on which the balloons are mounted.

Walther, Erhardt, and Dammig, Werner. **Method of and apparatus for sealing the layers of the sealing bands of cartons.** U. S. pat. 2,974,460. Filed July 15, 1957. 2 claims. Assigned to Regnitz Konstriktionsgesellschaft m.b.H. [Cl. 53-373.] Means are provided to heat-seal marginal strips of a carton to effect its closure.

Wilson, Lawrence A., and Wheeler, Wendell J. **Card transport.** U. S. pat. 2,974,951. Filed Dec. 31, 1956. 2 claims. Assigned to International Business Machines Corp. [Cl. 271-51.]

An improved card-transporting station is provided in a machine for processing record cards.

Windstrup, Robert F., Boehler, Joseph, and Schneider, Walter. **Carton forming and lining machine.** U. S. pat. 2,974,571. Filed April 9, 1956. 6 claims. Assigned to Peters Machinery Co. [Cl. 93-36.01.]

Zeuthen, Karl G. **Registering mechanism for the accurate feed of sheets of paper to a printing device, particularly to duplicating machines.** U. S. pat. 2,974,952. Filed June 10, 1957. 4 claims. Assigned to Zeuthen & Aagaard A/S. [Cl. 271-53.]

March 21, 1961

Aronson, Theodore F., and Lyon, Floyd A. **Continuous feed banding device.** U. S. pat. 2,975,571. Filed Dec. 2, 1959. 12 claims. [Cl. 53-198.] A band is sealed around a pack of envelopes.

Arthur, Wilfred J. **Process for the treatment of cellulosic materials to prevent deterioration and decay.** U. S. pat. 2,976,183. Filed Aug. 27, 1958. 2 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 117-138.5.] Wood chips and pulp are among the materials treated.

Ball, Frank J., and Pueschel, Richard. **Treatment of kraft black liquor and product.** U. S. pat. 2,976,273. Filed Sept. 10, 1958. 8 claims. [Cl. 260-124.] Dimethyl sulfide, low m.w. aliphatic acids, and a modified lignin product are produced.

Block, Pedro. **Package for cigarettes and matches.** U. S. pat. 2,975,890. Filed Nov. 21, 1958. 2 claims. [Cl. 206-48.] A card of matches is included in the front panel construction of a flip-top cigarette box.

Bosche, Walwin J., Jr. **Chick boxes and spacing cleats.** U. S. pat. 2,975,951. Filed April 23, 1958. 3 claims. Assigned to The Lawrence Paper Co. [Cl. 229-6.] A paperboard spacer element is placed between chick boxes in a stack to provide for ventilation.

Brechner, Hyman. **Apparatus for payroll system.** U. S. pat. 2,976,062. Filed Jan. 7, 1958. 7 claims. [Cl. 282-29.] A number of ledger and other sheets involved in a payroll system are mounted in a certain relation to each other in a binder.

Brown, Dennis D. **Bubble package.** U. S. pat. 2,975,889. Filed March 27, 1959. 3 claims. Assigned to Kem Mfg. Co., Inc. [Cl. 206-45.34.] The package includes a plastic dome and a paperboard backing card.

Cannon, Madison M., Dick, George M., and Salomon, Salomon M. **Screening device.** U. S. pat. 2,975,899. Filed April 16, 1957. 10 claims. Assigned to Bird Machine Co. [Cl. 209-273.] Means are provided to remove accumulated materials from a cylindrical screen for paper stock.

Foland, Howard L. **Display rack.** U. S. pat. 2,975,905. Filed July 2, 1959. 2 claims. [Cl. 211-50.] The rack, for pamphlets or the like, is formed of paperboard.

Garapolo, Orlando. **Selective card dispensing tray.** U. S. pat. 2,975,576. Filed June 2, 1955. 5 claims. Assigned to Wilson & Co., Inc. [Cl. 53-391.] Paperboard backing cards are dispensed in a bacon packaging system.

Garnett, Donald W. **Packaging apparatus.** U. S. pat. 2,975,568. Filed June 21, 1957. 33 claims. Assigned to The Olofsson Co. [Cl. 53-53.] Bags are filled with potato chips.

Gericke, Erich. **Sheet feeder for printing and duplicating machines.** U. S. pat. 2,976,036. Filed Nov. 25, 1957. 1 claim. [Cl. 271-5.] The sheets are fed so as to facilitate their registration.

Glab, William T. **Lignocellulose product and method.** U. S. pat. 2,976,164. Filed Sept. 25, 1958. 17 claims. Assigned to Durel, Inc. [Cl. 106-163.] A molding composition for making board and the like is formed by reacting lignocellulose with a chloride catalyst.

Goldberg, Harry. **Cut and scored tabs in cardboard collar.** U. S. pat. 2,975,862. Filed May 27, 1958. 6 claims. Assigned to Modern Dust Bag Co., Inc. [Cl. 183-51.] The construction of a filter paper vacuum cleaner bag includes an improved paperboard mounting plate.

Hinman, Burton L. **Mechanism for deleaving carbon strips.** U. S. pat. 2,975,989. Filed July 10, 1957. 6 claims. Assigned Uarco, Inc. [Cl. 242-56.5.]

Hirsch, Siegfried. **Hydrocyclone for fibres suspension.** U. S. pat. 2,975,896. Filed Aug. 17, 1959. 4 claims. [Cl. 209-211.]

Jorgenson, Ralph J., and Grant, Frank A. **Flexible cover applicator.** U. S. pat. 2,975,574. Filed Feb. 29, 1960. 5 claims. Assigned to Pacific Coast Foil Co. [Cl. 53-287.] Cover sheets of paper or other material are applied over the top of a tray holding a food product.

Kurhmeyer, Carl A. **Heat-sensitive copy-paper.** U. S. pat. 2,976,415. Filed July 21, 1958. 4 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 250-65.]

Leavitt, James P. H. **Container for packaging yarn cones.** U. S. pat. 2,975,892. Filed June 16, 1958. 4 claims. Assigned to Container Corp. of Am. [Cl. 206-65.]

Lehner-Stirnemann, Max. **System for the packing of eggs.** U. S. pat. 2,975,683. Filed July 16, 1959. 4 claims. [Cl. 93-37.] An egg carton is erected and filled.

McCurry, Thomas M. **Heat sealable stepped end bag.** U. S. pat. 2,975,955. Filed April 30, 1959. 6 claims. Assigned to Union Bag-Camp Paper Corp. [Cl. 229-55.] A multi-ply paper bag includes an inner ply coated with or formed of heat-sealable polyethylene.

MacLeod, Donald. **Filled container caser.** U. S. pat. 2,975,569. Filed March 18, 1958. 18 claims. Assigned to Tech-Art Inc. [Cl. 53-62.] A machine for casing paperboard milk cartons is designed to handle a variety of sizes of cartons.

Maeder, Arthur, Weber, Theodor, Sulzer, Georg, Fatzer, Willy, and Guertler, Pater. **Process for improving fibrous material and composition therefor.** U. S. pat. 2,976,167. Filed July 9, 1956. 21 claims. Assigned to Ciba, Ltd. [Cl. 117-33.] Compositions of use as a binder in the pigment printing and dyeing of cellulosic and other materials are provided.

Magnani, Alessandro. **Apparatus for manufacturing sheets of fibrous materials.** U. S. pat. 2,975,833. Filed June 5, 1959. 3 claims. [Cl. 162-318.] A cylinder machine is provided for forming paper, board, and asbestos-cement articles.

Monroe, Charles Z., and Egleston, Harry B. **Sealing and stapling mechanism for container fabricating machine.** U. S. pat. 2,975,570. Filed April 9, 1959. (Divided; original filed July 16, 1957.) 5 claims. Assigned to Ex-Cello-O Corp. [Cl. 53-138.] Gable-top milk cartons are formed, filled, and closed.

Moser, Henry W., Grobman, William and Eskilson, Ewald, O. P. **Printer-slotter machines.** U. S. pat. 2,975,706. Filed Oct. 23, 1958. 15 claims. Assigned to Samuel M. Langston Co. [Cl. 101-181.]

Muth, Richard J. **Carton with cover lock.** U. S. 2,975,953. Filed April 24, 1958. 2 claims. Assigned to Container Corp. of Am. [Cl. 229-45.]

Otrhalek, Joseph V. **Bottle washing composition and method.** U. S. pat. 2,976,248. Filed Aug. 1, 1957. 9 claims. Assigned to Wyandotte Chemicals Corp. [Cl. 252-156.] Lignosulfonates are used.

Paddison, Osborne H., and Sommers, Roy W. **Process for the manufacture of carboxymethyl cellulose involving 3-component, 2-phase reaction medium.** U. S. pat. 2,976,278. Filed Oct. 1, 1956. 6 claims. Assigned to E. I. du Pont de Nemours & Co. [Cl. 260-231.]

Powell, Truman W. **Packaging carrier separable into individual and multiple carrier units.** U. S. pat. 2,975,934. Filed Sept. 17, 1958. 2 claims. [Cl. 220-112.] A six-pack carrier for cans may be separated into carriers for single cans.

Robinson, Edward N., Appleman, Mark J., Miller, Leonard W., and Singer, Leonard. **Impression record envelope.** U. S. pat. 2,975,956. Filed Feb. 26, 1958. 3 claims. Assigned to Impress-A-Key Corp. [Cl. 229-68.] A paper envelope for recording and storing a key impression is provided.

Ronci, John J. **Talking greeting card.** U. S. pat. 2,976,049. Filed Dec. 10, 1957. 1 claim. [Cl. 274-16.] A phonograph disk and needle are mounted on a greeting card.

Royce, Mark B. **Ventilated shipping container for fruits and vegetables.** U. S. pat. 2,975,926. Filed Dec. 12, 1956. 1 claim. Assigned to Continental Can Co., Inc. [Cl. 217-42.] The container is made of a combination of wood slats and paperboard.

Schlatter, Carl. **Process of producing viscose rayon.** U. S. pat. 2,976,113. Filed Nov. 3, 1954. 14 claims. Assigned to American Viscose Corp. [Cl. 18-54.] The coagulation modifiers are alkylene oxide adducts of 2-aliphatic substituted imidazolines.

Schilder, Albert W. **Conduit and fabricating material therefor.** U. S. pat. 2,975,808. Filed Dec. 10, 1956. 6 claims. Assigned to Lynn Corp., Inc. [Cl. 138-74.] Foil-board laminates are used in making a conduit for an air heating system.

Sheetz, Charles A. **Drive mechanism for a bagging machine.** U. S. pat. 2,976,007. Filed Sept. 17, 1957. 15 claims. Assigned to Food Machinery and Chem. Corp. [Cl. 249-62.]

Snead, Charles D., and Peters, Ralph W. **Preparation of webs and sheets from cellulose esters.** U. S. pat. 2,976,205. Filed Sept. 9, 1955. 7 claims. [Cl. 162-157.]

Snelson, Howard J., and Prior, Willim L. **Apparatus for steam treating fibrous panels.** U. S. pat. 2,975,470. Filed Jan. 9, 1958. 11 claims. Assigned to Tectum Corp. [Cl. 18-4.] Steam is used to set the magnesium cement binder used in a fibrous wood wool board.

Sosnowich, Michael. **Mounting disposable vacuum cleaner bags, by means of rigid member with slotted corners.** U. S. pat. 2,975,863. Filed May 27, 1958. 1 claim. Assigned to Modern Dust Bag Co., Inc. [Cl. 183-51.] An improved mounting frame is provided in a paper filter bag of use in vacuum cleaners.

Sparks, George C. **Easy-opening setup box.** U. S. pat. 2,975,954. Filed May 15, 1959. 3 claims. [Cl. 229-51.] This is a box for mailing advertising samples or the like.

Stone, Orison W. **Locking construction for paperboard car-**

tons. U. S. pat. 2,975,891. Filed June 24, 1957. 1 claim. Assigned to Continental Can Co., Inc. [Cl. 206-65.] Improved self-locking means are provided to secure a paperboard blank about cans to form a six-pack carrier.

Tamarin, Richard B. **Container closure.** U. S. pat. 2,975,952. Filed Oct. 8, 1957. 2 claims. [Cl. 229-7.] A carton includes a sliding closure element in the top panel construction.

Touey, George P., and Tamblyn, John W. **Method of preparing cellulose esters.** U. S. pat. 2,976,277. Filed April 9, 1959. 5 claims. Assigned to Eastman Kodak Co. [Cl. 260-227.]

Weinar, Roger N., and Eder, John A. **Combined holder and handle for cartons.** U. S. pat. 2,976,074. Filed April 11, 1958. 2 claims. [Cl. 294-33.] A handled support for a gable-top milk carton, formed of wire, is provided.

Wertheimer, Milton A. **Apparatus for wrapping and heat-sealing packages.** U. S. pat. 2,975,572. Filed Feb. 7, 1958. 13 claims. Assigned to Gellman Mfg. Co. [Cl. 53-206.] Sheets of wrapping material are sealed around open-top trays holding a good product or the like.

Whyte, Fred. **Feed mechanisms for printing and like machines.** U. S. pat. 2,976,038. Filed June 17, 1957. 4 claims. [Cl. 271-60.]

Young, Harold C., and Toy, Walter W. **Adhesive composition methods of employing it, and laminated structures.** U. S. pat. 2,976,203. Filed Sept. 6, 1957. 12 claims. Assigned to Rohm & Haas Co. [Cl. 154-140.] The adhesive is of use on paper and other surfaces.

Young, Harold C., and Toy, Walter W. **Adhesive compositions, methods of employing them, and laminated structures made therefrom.** U. S. pat. 2,976,204. Filed Sept. 6, 1957. 20 claims. Assigned to Rohm & Haas Co. [Cl. 154-140.] This is an acrylic adhesive for bonding paper.

Zalkind, Joseph. **Multi-color writing transfer sheet.** U. S. pat. 2,976,165. Filed Jan. 31, 1958. 2 claims. [Cl. 117-15.]

March 28, 1961

Aronson, Theodore F., Kronman, Albert F., and Lyon, Floyd A. **Gummed label applying device.** U. S. pat. 2,977,016. Filed Dec. 18, 1958. 6 claims. [Cl. 216-37.]

Asp, Nils A. R. **Apparatus for automatically loading bags on a pallet.** U. S. pat. 2,977,002. Filed Aug. 29, 1958. 2 claims. Assigned to Aktiebolaget Abjorn Anderson. [Cl. 214-6.]

Bartlett, William. **Pressure sensitive tape can and dispenser.** U. S. pat. 2,977,034. Filed March 9, 1959. 2 claims. [Cl. 225-47.]

Baxter, Joseph, Jr. **Paper machinery.** U. S. pat. 2,976,924. Filed April 25, 1956. 2 claims. Assigned to Black-Clawson Co. [Cl. 162-273.] Improved tensioning means are provided for a fourdrinier wire.

Bradshaw, William H., and Shaw, Edward H. **Alkali cellulose aging.** U. S. pat. 2,977,355. Filed Jan. 13, 1954. 13 claims. Assigned to Celanese Corp. of Am. [Cl. 260-233.]

Brysson, Ralph J., and Reeves, Wilson A. **Metallic selenide fungicides for outdoor cellulosic textiles.** U. S. pat. 2,977,250. Filed May 5, 1960. 1 claim. Assigned to United States of America. [Cl. 117-138.5.]

Carmellini, Andrew E., and Hotelling, Eric B. **Tobacco sheet.** U. S. patent 2,976,873. Filed Feb. 16, 1960. (Divided; original filed April 6, 1959.) 3 claims. Assigned to American Machine & Foundry Co. [Cl. 131-140.] Various cellulose derivatives are used as binders.

Cloud, Charles E. **Packaging with variations of package length.** U. S. pat. 2,976,657. Filed Oct. 16, 1958. 19 claims. Assigned to William S. Cloud. [Cl. 53-75.] This is a machine of the type in which packaging material is formed into a tube about articles and sealed and severed between them.

Colliva, Dante. **Method and machine for manufacturing asbestos cement tubes.** U. S. pat. 2,977,276. Filed Aug. 10, 1955. 13 claims. Assigned to Johns-Manville Corp. [Cl. 162-118.]

Commerford, John D., and Ehrenthal, Irving. **Process for preparing cross-linked starch ethers in granule form.** U. S. pat. 2,977,356. 4 claims. Assigned to Anheuser-Busch, Inc. [Cl. 260-233.3.] The products are of use in paper coating.

Cooke, Brian A., Morgan, Thomas D., and Schweigart, Hildegard E. L. G. **High selectivity and conductivity permselective membranes and process for producing same.** U. S. pat. 2,977,298. Filed Nov. 5, 1957. 14 claims. Assigned to South African Council for Sci. and Ind. Research. [Cl. 204-296.] The membranes are formed from parchment paper.

Douthitt, Merton H. **Packaging of tacky materials.** U. S. pat. 2,977,267. Filed Dec. 6, 1955. 2 claims. Assigned to Texaco Devt. Corp. [Cl. 154-79.] Paper cover sheets are adhered to a sticky slab of rubber.

Edminster, Robert E. **Document stacker.** U. S. pat. 2,977,116. Filed June 4, 1957. 1 claim. Assigned to Intern. Business Machines Corp. [Cl. 271-88.]

Ericks, Walter P. **Process of stabilizing cellulose by impregnation with a salt of an organic basic nitrogen compound containing a hydroxyl group and a partial ester of a polyhydric alcohol and polycarboxylic acid and product thereof.** U. S. pat. 2,977,331. Filed Oct. 20, 1955. 4 claims. [Cl. 260-17.2.] Paper is dimensionally stabilized to varying humidity.

Fischer, John R., and Johnstone, Hugh R. **Process for coating film.** U. S. pat. 2,977,246. Filed June 3, 1958. 5 claims. Assigned to E. I. du Pont de Nemours & Co. [Cl. 117-76.] A coated cellophane is provided.

Flanagan, James R., and Hoopes, Penrose R. **Article packing apparatus.** U. S. pat. 2,976,659. Filed Sept. 17, 1958. 40 claims. Assigned to Stephen F. Whitman and Son, Inc. [Cl. 53-237.] Pieces of candy are packed in glassine cups and the cups are arranged in rows and layers in trays.

Flowers, Fred C. **Gasket and method of making same.** U. S. pat. 2,977,248. Filed Oct. 15, 1958. 8 claims. Assigned to General Motors Corp. [Cl. 117-126.] The gasket material is a rubber-bonded asbestos fiber mat coated with an epoxy resin.

Ford, Barton H. **Disposable pallet.** U. S. pat. 2,977,148. Filed July 11, 1957. 2 claims. Assigned 50% to Intern. Paper Co., and 50% to the Stanley Works. [Cl. 294-74.] The pallet is made of a loop of corrugated reinforced with metal strapping.

Gardon, John L., and Leopold, Bengt. **Process for obtaining infusible products of high carbon contents from lignin sulphonates.** U. S. pat. 2,977,352. Filed July 25, 1958. 5 claims. Assigned to Canadian Intern. Paper Co. [Cl. 260-124.]

Gray, Willard F. M., and Moser, Rene O. **Electrical coil.** U.S. pat. 2,977,556. Filed March 15, 1957. 1 claim. Assigned to General Elec. Co. [Cl. 336-185.] Kraft paper is used as insulation.

Griset, Ernest J., Jr., and Thurmond, Gilbert I. **Production of rayon.** U. S. pat. 2,977,184. Filed June 16, 1953. Assigned to American Enka Corp. [Cl. 18-54.] A high-tenacity rayon filament is produced.

Hall, Harry H. **Process of producing all skin rayon.** U. S. pat. 2,977,238. Filed Nov 21, 1958. (Divided; original filed Dec. 30, 1954.) 9 claims. Assigned to American Viscose Corp. [Cl. 106-165.] The coagulation modifier is a phosphoric acid ester of an alkylene oxide adduct of fatty alcohols.

Hamilton, Joseph P., and Burkhardt, George C. **Pallet making machine and process.** U. S. pat. 2,976,779. Filed Dec. 3, 1956. 5 claims. Assigned to Charles Dreifus, Jr. [Cl. 93-1.] Wooden stringers are inserted through openings in paperboard cross members.

Hansen, Paul E., and Oace, Ralph J. **Grass-growing fabric.** U. S. pat. 2,976,646. Filed April 1, 1958. 5 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 47-56.] A product for planting grass seed comprises a nonwoven web including grass seed distributed therein.

Hanson, Walter J., and Schmeck, Robert E. **Document feeding apparatus.** U. S. pat. 2,977,114. Filed Aug. 6, 1956. 8 claims. Assigned to Pitney-Bowes, Inc. [Cl. 271-32.] Improved feeding means are provided in a machine for sorting checks or the like.

Hart, Oscar D. **Fastener assembly for joint for paper machine drier felts.** U. S. pat. 2,976,537. Filed Aug. 2, 1955. 1 claim. [Cl. 1-56.]

Herzig, Leonard A. **Microfilm record card.** U. S. pat. 2,977,017. Filed July 28, 1958. 2 claims. Assigned to P.C.I., Inc. [Cl. 216-62.]

Heyden, Rudi, and Wedell, Hans. **Process for waterproofing fibrous materials.** U. S. pat. 2,977,249. Filed June 11, 1957. 5 claims. Assigned to Bohme Fettchemie G.m.b.H. [Cl. 117-135.5.]

Hollis, Robert F. **Digestion of pulp.** U. S. pat. 2,977,274. Filed July 24, 1957. 5 claims. Assigned to Alton Box Board Co. [Cl. 162-4]. A process for preparing wastepaper stock for papermaking is designed to effect dispersion of asphalt and other thermoplastic contaminants.

Honstein, Victor, Lohrmann, Erich, Schneider, Max, and Küsel, Ernst. **Apparatus for unwinding a supply roll in paper processing machines.** U. S. pat. 2,977,058. Filed Dec. 15, 1958. 4 claims. Assigned to Jagenberg–Werk A.G. [Cl. 242-55.1.]

Kelly, Jack R. **Method and apparatus for making a web of fibrous material.** U. S. pat. 2,977,277. Filed July 15, 1957. 17 claims. [Cl. 162-203.] In a paper machine, the web is formed on a vertical wire as it passes upward.

Korican, Otto H. **Room temperature laminating composition and method of making laminated products.** U. S. pat. 2,977,273. Filed Nov. 28, 1956. 10 claims. [Cl. 154-140.] This is an adhesive of use in laminating decorative laminates.

Kostur, J. Edward. **Machines for automatically skin packaging merchandise articles and for cutting into separate packages.** U. S. pat. 2,976,658. Filed Dec. 7, 1959. 8 claims. [Cl. 53-112.]

LaFave, Francis G. **Insert for bag valves.** U. S. pat.

2,977,038. Filed Jan. 22, 1958. 3 claims. Assigned to St. Regis Paper Co. [Cl. 229-62.5.]

Lutwack, Wilton J. **Method of making laminated protective book cover.** U. S. pat. 2,977,271. Filed Dec. 31, 1956. 2 claims. [Cl. 154-118.] Paper and plastic sheets are combined to form a windowed cover.

Lutz, Lewis W. **Adhesive applicator means particularly adapted for corrugating machines.** U. S. pat. 2,977,247. 13 claims. Assigned to Packaging Corp. of Am. [Cl. 117-111.]

Malin, Herman J., and Westermeier, Donald H. **Card processing apparatus.** U. S. pat. 2,977,113. Filed June 29, 1959. 15 claims. Assigned to Magnavox Co. [Cl. 271-11.] A feeding-stacking magazine is provided in a machine for processing data cards.

Mason, Jack H. **Record sheet and stencil assembly.** U. S. pat. 2,976,802. Filed March 26, 1958. 1 claim. Assigned to The Multistamp Co. [Cl. 101-128.1.]

Nevai, Bela B. **Retaining sleeve for hanger sets.** U. S. pat. 2,976,990. 3 claims. [Cl. 206-65.] A paperboard blank is formed into a sleeve for holding a number of garment hangers of various sizes.

Offner, Franklin F. **Paper drive.** U. S. pat. 2,977,112. Filed July 15, 1957. 7 claims. [Cl. 226-185.] Recording paper is fed to an oscillograph.

Paschal, Don F. **Display mounts for calendar pads or the like.** U. S. pat. 2,976,631. Filed Feb. 8, 1960. 3 claims. Assigned to Chronicle Publishing Co. [Cl. 40 120.]

Peterson, W. Jerome. **System of merchandising and equipment therefor.** U. S. pat. 2,976,653. Filed Oct. 10, 1955. 29 claims. [Cl. 53 3.] A retail store check-out counter construction includes means for forming a bag about the articles purchased.

Piazze, Thomas E. **Container filling and closing machine.** U. S. pat. 2,976,660. Filed April 22, 1959. 23 claims. Assigned to Continental Can Co., Inc. [Cl. 53-266.] Flat-bottom bags are filled and closed.

Potts, John. **Loose leaf binder.** U. S. pat. 2,976,871. Filed Sept. 27, 1957. 9 claims. Assigned to Wilson-Jones Co. [Cl. 129-17.]

Pounds, Lewis C. **Laminated articles.** U. S. pat. 2,977,272. Filed June 12, 1957. 8 claims. Assigned to American Cyanamid Co. [Cl. 154-132.] A resin-impregnated paper for lamination to a core of particle board or the like is provided.

Quittner, George F. **Method for the continuous testing of flowing materials.** U. S. pat. 2,977,199. Filed Dec. 31, 1956. 5 claims. Assigned to Ind. Rayon Corp. [Cl. 23-230.] The method may be applied to the control of the composition of a rayon spin bath.

Rushmore, Donald. **Paper contamination classifier.** U. S. pat. 2,976,719. Filed Oct. 23, 1956. 5 claims. [Cl. 73-61.] An apparatus is provided for determining the foreign matter content of waste paper.

Schneider, William S. **Unit dispensing container.** U. S. pat. 2,976,988. Filed June 25, 1957. 5 claims. [Cl. 206-56.] Two sheets of paper or film are sealed together to form a packet for holding and dispensing measured quantities of pills, liquids, etc.

Shiels, Thomas E., Jr. **Compartmented bottle carriers.** U. S. pat. 2,977,021. Filed Aug. 11, 1958. 3 claims. Assigned to Fleming & Sons, Inc. [Cl. 220-115.]

Standal, George M. **Chipper knife grinder.** U. S. pat. 2,976,649. Filed May 15, 1959. 4 claims. [Cl. 51-55.]

Tanner, Howard A. **Fibrous microwave absorber.** U. S. pat. 2,977,591. Filed Sept. 17, 1952. 2 claims. [Cl. 343-18.] A fibrous mass is coated with conductive carbon particles in a rubber binder.

Tilton, William J., and Moore, Kenneth N. **Compensating means for web feeder.** U. S. pat. 2,977,035. Filed Dec. 18, 1957. 15 claims. Assigned to Raymond Bag Corp. [Cl. 226-31.] Printed portions of the web are maintained in registry with the operating stations.

Vandeman, Jack E. **Front register mechanism.** U. S. pat. 2,977,115. Filed June 10, 1958. 18 claims. Assigned to Harris-Intertype Corp. [Cl. 271-53.]

Vogt, Clarence W. **Method and apparatus for filling gusseted containers.** U. S. pat. 2,976,654. Filed Aug. 8, 1957. 15 claims. [Cl. 53 37.]

Voigt, John E., Horst, Raymond J., and Sowell, Ernest A. **Process for preparing a thick-thick boiling starch derivative.** U. S. pat. 2,977,357. Filed Aug. 14, 1958. 2 claims. Assigned to Anheuser-Busch, Inc. [Cl. 260-233.3.]

Weisner, Max. **Light-tight film packs for daylight development.** U. S. pat. 2,976,989. Filed Aug. 28, 1956. 3 claims. Assigned to Agfa AG. [Cl. 206-62.]

Work, Lincoln T. **Continuous digestion process and apparatus.** U. S. pat. 2,977,275. Filed Sept. 9, 1955. 13 claims. Assigned to Texaco Devt. Corp. [Cl. 162-64.]

Youngchild, Casper E. **Reinforced suction box cover.** U. S. pat. 2,976,925. Filed Feb. 3, 1958. 4 claims. Assigned to Appleton Wood Prods. Co. [Cl. 162-374.]

The following patents were received later than those of the same issue date and have accumulated during the past quarter.

June 25, 1957

Gimler, John R. **Coating composition.** U. S. pat. 2,797,168. Filed Dec. 1, 1953. 2 claims. [Cl. 106-268.] A wax composition for coating and sealing cartons is provided.

April 7, 1959

Sperry, Russell L. **Polycarboxylic acids and alkali metal salts thereof from carbohydrates.** U. S. pat. 2,881,211. Filed Jan. 12, 1956. 11 claims. [Cl. 260-528.] The carbohydrates include pulp and paper; the product is a drilling fluid additive.

Dec. 22, 1959

Widmer, Gustav. **Dry preparations capable of yielding cation-active melamine resin solutions by dissolution in water and ripening and process for their manufacture.** U. S. pat. 2,918,453. Filed Nov. 19, 1956. 9 claims. Assigned to Ciba, Ltd. [Cl. 260-67.6.] The solutions are of use in making wet-strength paper.

Aug. 9, 1960

Kranz, Frederick H. ***N*-Bis(*p*-dialkylaminophenyl)methyl sulfonamides.** U. S. pat. 2,948,753. Filed May 12, 1958. 14 claims. Assigned to Allied Chem. Corp. [Cl. 260-556.] These compounds are of use in coatings for preparing colorless carbon papers and the like.

Aug. 23, 1960

Lagally, Paul. **Preparation and stabilization of water soluble reactive titanium derivatives.** U. S. pat. 2,950,174. Filed April 5, 1956. 12 claims. [Cl. 23-202.] The compositions provided are of use in cross-linking cellulose, as in making wet-strength paper.

Schrier, Harold D. **Coating composition.** U. S. pat 2,950,210. Filed Dec. 8, 1958. 2 claims. [Cl. 106-230.] A nonblocking heat sealable coating for application to paper or other materials is provided.

Aug. 30, 1960

Rowland, Ben W. **Clay products and method of reducing clay viscosity.** U. S. pat. 2,950,983. Filed Dec. 1957. 8 claims. Assigned to Georgia Kaolin Co. [Cl. 106-288.] A method is provided for reducing the viscosity of clays for paper coating.

Sept. 13, 1960

Fischer, Webster E., and Fox, Francis E., Jr. **Gel-point indicator.** U. S. pat. 2,952,152. Filed Feb. 21, 1955. 5 claims. Assigned to Eastman Kodak Co. [Cl. 73-17.] An apparatus is provided for determining the gel point of a solution of a cellulose derivative.

Sept. 20, 1960

Gray, Daniel M. **Battery separators and production thereof.** U. S. pat. 2,953,622. Filed Feb. 26, 1957. 14 claims. Assigned to American-Marietta Co. [Cl. 136-143.] The separator is produced from paper impregnated with a copolymer of vinylidene chloride.

Mones, Arthur H. **Electrolytic recording medium.** U. S. pat. 2,953,505. Filed Dec. 1, 1954. 6 claims. Assigned to Hogan Faximile Corp. [Cl. 204-2.] An electrosensitive recording paper is provided.

Oct. 4, 1960

Brodkey, Robert S., and Miller, Alfred L. **Process for preparing stable isoolefin-multiolefin rubbery polymer latices containing ortho-phosphoric acid and organic sulfate salts.** U. S. pat. 2,955,904. Filed June 21, 1956. 13 claims. Assigned to Esso Research and Eng. Co. [Cl. 260-29.7.] The latex is of use in sizing or laminating.

Hudgin, Donald E. **Cured reaction product of unsaturated acetal, polyhydroxyalcohol and cellulose and process for preparing same.** U. S. pat. 2,955,902. Filed April 9, 1957. 14 claims. Assigned to Celanese Corp. of Am. [Cl. 260-17.4.] The product may be in the form of a paper laminate.

Maloney, William T. **Treatment of clays and clay products produced thereby.** U. S. pat. 2,955,051. Filed Aug. 27, 1956. 12 claims. [Cl. 106-292.] A paper-coating clay of improved brightness is prepared.

Segal, Leon, Loeb, Leopold, and Conrad, Carl M. **Process of treating native cellulose with a liquid alkylenepolyamine and a textile resin.** U. S. pat. 2,955,014. Filed March 4, 1955.

1 claim. Assigned to The United States of Am. [Cl. 8-115.6.] A process for making resin-impregnated cellulose fibers having reduced crystallinity without having reduced strength is provided.

Oct. 18, 1960

Fleck, Fritz. **Brightening agents.** U. S. pat. 2,956,898. Filed Sept. 3, 1958. 11 claims. Assigned to Sandoz, Ltd. [Cl. 117-33.5.] These are optical brighteners for paper and the like.

Oct. 25, 1960

Burns, Thomas S., and McDaniel, Olin K. **Separation of phytosterol from unsaponifiables.** U. S. pat. 2,957,891. Filed Feb. 27, 1957. 3 claims. Assigned to Union Bag-Camp Paper Corp. [Cl. 260-397.25.] Phytosterol is produced from black liquor skimmings.

Johnson, Gordon C., and Jellinek, Maurice H. **Composition containing water soluble substituted silane and zirconium oxychloride and method of treating material therewith.** U. S. pat. 2,957,839. Filed Jan. 18, 1956. 21 claims. Assigned to Union Carbide Corp. [Cl. 260-29.2.] This is a waterproofing composition for paper.

Nov. 15, 1960

Miller, Ivan K. **Extruding a ferrocyanide containing viscose into a nickel salt containing bath.** U. S. pat. 2,960,385. Filed Oct. 16, 1957. 7 claims. Assigned to E. I. du Pont de Nemours & Co. [Cl. 18-54.]

Rosenwald, Robert H., and Gleim, William K. T. **Preparation of antiozonants from wood tar distillate.** U. S. pat. 2,960,539. Filed Oct. 18, 1957. 3 claims. Assigned to Universal Oil Prods. Co. [Cl. 260-613.]

Nov. 29, 1960

Green, Barrett K. **Oil-containing microscopic capsules and method of making them.** U. S. pat. Re. 24,899. Filed July 22, 1958. (Divided; original filed July 23, 1957.) 18 claims. Assigned to Natl. Cash Register Co. [Cl. 252-316.] The capsules are of use in a transfer composition for coating paper.

Johnson, Dale W., and Julian, Percy L. **Process for removing sulfur dioxide from aqueous liquors.** U. S. pat. 2,962,421. Filed Oct. 28, 1952. 20 claims. Assigned to The Glidden Co. [Cl. 195-39.] The liquor may be spent sulfite liquor.

Dec. 6, 1960

Allen, Simeon C. **Preservation of foods.** U. S. pat. 2,963,375. Filed Jan. 13, 1960. 4 chains. [Cl. 99-171.] Paper wrappers are used to package foods so as to preserve sterility without hermetic sealing.

Back, Sangho, Hinrichs, Delmer D., and Wethern, James D. **Process of bleaching lignocellulosic pulps.** U. S. pat. 2,963,395. Filed March 31, 1958. 15 claims. Assigned to Crown Zellerbach Corp. [Cl. 162-83.]

Chase, Corson W., Jasinowski, Walter J., and Pedersen, Arne V. **Web splicing apparatus.** U. S. pat. 2,963,234. Filed April 21, 1955. 28 claims. Assigned to Miehle-Goss-Dexter, Inc. [Cl. 242-58.3.]

Drugge, Carl E., and Hine, John M. **Glue mix.** U. S. pat. 2,963,454. Filed April 11, 1957. 7 claims. Assigned to The Borden Co. [Cl. 260-9.] This is a protein-polyvinyl acetate glue for laminating paper to wood.

Eichorn, Robert N., and Cannon, Maxwell R. **Apparatus for handling a continuous web of material.** U. S. pat. 2,963,087. claims. Assigned to Intern. Business Machines Corp. [Cl. 162-252.] A machine for making data cards is provided with means for preventing curvature in the cards.

Keller, Robert C. **Retarding and levelling agents.** U. S. pat. 2,963,339. Filed Feb. 6, 1959. 16 claims. Assigned to Sandoz, Ltd. [Cl. 8-87.] Tall oil fatty acids are used.

McLeod, Thomas S. **Method and apparatus for producing quality controlled pulp molded articles.** U. S. pat. 2,963,397. Filed June 21, 1957. 5 claims. Assigned to The Plessey Co., Ltd. [Cl. 162-198.]

Padbury, John J., Thomas, Walter M., and Schuller, Walter H. **High dry strength-low wet strength paper.** U. S. pat. 2,963,396. Filed Dec. 6, 1957. 6 claims. Assigned to American Cyanamid Co. [Cl. 162-168.]

Pedersen, Arne V., and Wolff, Roger E. **Automatic web splicing apparatus.** U. S. pat. 2,963,235. Filed June 11, 1957. 30 claims. Assinged to Miehle-Goss-Dexter, Inc. [Cl. 242-58.3.]

Weschler, Joseph R., and Bartell, Charles. **Pressure sensitive adhesive tape.** U. S. pat. 2,963,386. Filed May 20, 1957. 2 claims. Assigned to Johnson & Johnson. [Cl. 117-122.]

Wurdack, William D. **Nylon coating.** U. S. pat. 2,963,385. Filed April 28, 1958. 6 claims. [Cl. 117-73.] Cellulose nitrate and rosin are used.

Dec. 13, 1960

Akimoto, Saihei. **Flexible hinges of book panel boards.** U. S. pat. 2,964,336. Filed June 25, 1957. 1 claim. [Cl. 281-29.]

Ashton, William H., and Morse, Edward A. **Absorbent product.** U. S. pat. 2,964,040. Filed July 23, 1956. 16 claims. Assigned to Personal Prods. Corp. [Cl. 128-290.] An arcuately shaped sanitary napkin includes wood pulp and coated paper in its construction.

Ashton, William H., and Morse, Edward A. **Absorbent product.** U. S. pat. 2,964,041. Filed June 17, 1959. 16 claims. Assigned to Personal Prods. Corp. [Cl. 128-290.] An arcuately shaped sanitary napkin includes wood pulp and thermoplastic coated in its construction.

Asplund, Arne J. A. **Grinding apparatus for fibrous materials.** U. S. pat. 2,964,250. Filed July 15, 1954. 9 claims. Assigned to Aktiebolaget Defibrator. [Cl. 241-256.] Means are provided to adjust the relation between the working faces of the disks of a defibrator.

Beekman, Stewart M., and Cipriano, John F. **Surface-sizing of fibrous void-containing sheets with hydrous zirconium compounds.** U. S. pat. 2,964,403. Filed Sept. 1, 1955. 9 claims. Assigned one-half to Reheis Co., Inc. and one half to Adelphi Research & Mfg. Co. [Cl. 96-75.] A composition is provided for surface sizing photographic and other papers.

Bergstedt, Milton A., and Collins, John H. **Pressure sensitive adhesive sheet and method of manufacture.** U. S. pat. 2,964,422. Filed Feb. 28, 1958. 6 claims. Assigned to Johnson & Johnson. [Cl. 117-76.] A primer coating for use in making pressure-sensitive tape is provided.

Glab, William T. **Method of making a lignocellulose product and products resulting therefrom.** Assigned to Caradco, Inc. [Cl. 106-163.] This is a molding composition for use in making boards or the like.

Holtschmidt, Ulrich. **Process of impregnating paper to form laminated material.** U. S. pat. 2,964,426. Filed Nov. 20, 1958. 4 claims. Assigned to Th. Goldschmidt A.G. [Cl. 117-155.]

Johnson, Robert W., Jr., Mortimer, Robert J., and Ashton, William H. **Preformed, arcuate sanitary napkins.** U. S. pat. 2,964,039. Filed Jan. 18, 1955. 19 claims. Assigned to Personal Prods. Corp. [Cl. 128-290.] This is similar to U. S. pat. 2,964,040 (Dec. 13, 1960).

Korn, Paul P. **Gas filtering apparatus.** U. S. pat. 2,964,127. Filed April 21, 1959. 4 claims. Assigned to Arco Mfg. Corp. [Cl. 183-45.] The filter includes a bag formed of fibrous material and mounted in a paperboard frame.

Metzner, Albert W., Denges, Alfred J., and Ross, Harold F. **Manifold forms and processes of making them.** U. S. pat. 2,964,337. Filed March 8, 1957. 1 claim. Assigned to The Standard Register Co. [Cl. 282-21.]

Talbot, Ralph H., and Priest, William J. **Photographic products containing water-soluble salts of ethyl cellulose chlorophthalate.** U. S. pat. 2,964,405. Filed Aug. 8, 1958. 9 claims. Assigned to Eastman Kodak Co. [Cl. 96-113.]

Ulrich, Erwin W. **Pressure-sensitive adhesion sheet material.** U. S. pat. Re. 24,906. Filed May 8, 1959. 7 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 206-59.] An acrylic adhesive is provided.

Walker, Charles W. E. **Noise reducing means for high speed perforated surfaces.** U. S. pat. 2,964,107. Filed Aug. 1, 1955. 2 claims. Assigned to MacMillan Bloedel and Powell River, Ltd. [Cl. 162-371.] A noise-reducing couch roll construction is provided.

16th Engineering Conference
October 15–19, 1961
Shoreham Hotel, Washington, D. C.

Theme: "Cost Reduction Through Engineering"
Keynote Speaker: B. R. Cancell, Executive V.P.
St. Regis Paper Co.
New York, N. Y.
Banquet Speaker: James E. Webb, Administrator
National Aeronautics and Space Administration
Washington, D. C.
Conference Chairman: M. J. Osborne
Bowaters Southern Paper Corp.
Calhoun, Tenn.
Program Chairman: G. E. Shaad
General Electrical Co.
Schenectady, N. Y.
Ladies Program Chairman: Mrs. W. S. Allmond
Hopewell, Va.

SUSTAINING MEMBERS AND ADVERTISERS

Abbé Engineering Co.
Air Reduction Co., Inc.
Albany Felt Co.
Allied Chemical Corp.
General Chemical Div.
National Aniline Div.
Nitrogen Div.
Plastics Div. ..... 60 A
Solvay Process Div.
Allis-Chalmers Mfg. Co.
American Bitumels & Asphalt Co.
American Cyanamid Co. (Paper Chemical Dept.) ..... 35 A
American Cyanamid Co. (Pigments Div.) ..... 19 A
American Defibrator, Inc.
American Key Products, Inc.
American Marietta Co.
American Oil Co. (Industrial Div.)
American Potash & Chemical Corp.
American S. F. Products, Inc.
American Viscose Corp. ..... 23 A
Anaconda American Brass Co.
Analytical Measurements, Inc.
Anglo-American Clays Corp.
Anheuser-Busch, Inc. (Corn Products Div.)
Appleton Machine Co.
Appleton Wire Works, Inc.
Appleton Mills
Arabol Mfg. Co.
Armco Steel Corp.
Arnold, Hoffman & Co., Inc. ..... 67 A
Asten-Hill Mfg. Co.
Atlantic Refining Co. ..... 71 A
Atlas Chemical Corp. ..... 33 A

Babcock & Wilcox Co., The (Boiler Div.)
Babcock & Wilcox Co., The (Tubular Products Div.)
Bailey Meter Co. ..... 84 A
Bauer Bros. Co., The
Becco Chemical Div. (Food Machy. & Chemical Corp.)
Bechtel Corp.
Bellmer Maschinen Fabrik Kg
Beloit Eastern Corp. ..... 55 A
Beloit Iron Works ..... 37 A, 38 A
Betz Laboratories, Inc. ..... 81 A
Bird Machine Co. ..... 15 A
Black-Clawson Co., The ..... 65 A
Bolton & Son, Inc., John W. ..... 2nd Cover
Borden Co., The (Chem. Div.) (Polyco-Monomers)
Borden Co., The (Coating & Adhesives)
Bowen Corp., The
Brandon Sales, Inc.
Buckman Laboratories, Inc. ..... 4th Cover
Buckley, Dunton Pulp Co.
Bunge Pulp & Paper Co.
Burtonite Co., The

Cabble Wire Co., Inc.
Cady & Co., E. J.
Cameron Machine Co. ..... 43 A
Carborundum Company, The
Carthage Machine Co.
Catlin Corp. of America
Celgar, Ltd. ..... 74 A
Cellulose Sales Co., Inc.
Central Soya Co. (Chemurgy Div.)
Chain Belt Co.
Chelate Chemicals Corp. ..... 66 A
Chemipulp Process, Inc. ..... 129 A
Cheney Bigelow Wire Works
Chicago Bridge & Iron Co.
Chromium Corp. of America ..... 64 A
Ciba Company, Inc.
Cities Service Oil Co.
Clark-Aiken Co., The
Clark & Vicario Corp.
Cleary Corp., W. A.
Clinton Corn Processing Co. ..... 52 A
Colton Chemical Co. (Div. of Air Reduction Co., Inc.)
Columbia-Southern Chemicals (refer to Pittsburgh Plate Glass Co., Chemical Div.)
Comac Engineering, Inc.
Combustion Engineering, Inc.
Corn Products Co. (Industrial Div.) ..... 91 A
Crane Packing Co.
Crosby Chemicals, Inc.
Cummins & Barnard, Inc. ..... 203 A
Curtiss Wright Corp.

Darling & Co. ..... 29 A
Dexter Chemical Co. ..... 34 A
DeZurik Corp.
Diamond Alkali Co. ..... 82 A, 83 A
Dicalite Div. (Great Lakes Carbon Co.)
Dixon Chemical & Research, Inc. ..... 3rd Cover
Dominion Eng. Co., Ltd. ..... 90 A
Dorr-Oliver, Inc. ..... 86 A, 87 A
Dorries, A. G. O. ..... 62 A
Dow Chemical Co., The (Chem. Sales Dept.) ..... 76 A, 77 A
Dow Chemical Co., The (Coating Sales Dept.)
Dow-Corning Corp. ..... 105 A
Draper Bros. Co.
du Pont de Nemours & Co., Inc., E. I. (Dyestuffs)
du Pont de Nemours & Co., Inc., E. I. (Electrochemicals)
du Pont de Nemours & Co., Inc., E. I. (Pigments)
du Pont de Nemours & Co., Inc., E. I. (Vinyls)

Earl Paint Corp.
East Chicago Machine Tool Co.
Eaton Mfg. Co. (Dynamatic Div.) ..... 39 A
Ebasco Services, Inc.
Ehrsam & Sons Mfg. Co., J. B. ..... 44 A
Egan & Co., Frank W.
Eimco Corp., The
Electric Controller & Mfg. Co. (Div. Square D Co.)
Electric Machinery Mfg. Co.
ESCO Corp.
Elliott Co.
Endura Corp.
Epic, Inc. ..... 107 A

Fabri-Valve Co. of America ..... 127 A
Farrell-Birmingham Co., Inc.
Felker Bros. Mfg. Co.
Ferguson Co., The H. K. ..... 203 A
Fischer & Porter, Inc.
FMC Corp. (Chlor-Alkali Div.) ..... 57 A
Foxboro Co., The ..... 72 A
Freeport Sulphur Co.
Fuller Co., H. B.

Gardner International Corp. ..... 103 A
Geigy Chemical Corp.
General Dyestuff Co. (General Aniline & Film Corp.) ..... 9 A
General Electric Co.
General Tire & Rubber Co. (Chemical Div.)
Georgia Kaolin Co.
Gilbert Associates, Inc. ..... 203 A
Glidden Co., The (Chemicals Pigments-Metals Div.)
Goodyear Tire & Rubber Co., Inc. (Chem. Div.) ..... 11 A
Goslin-Birmingham Mfg. Co., Inc.
Gottesman & Co., Inc. ..... 47 A
Goulds Pumps, Inc. ..... 75 A
Graver Tank & Mfg. Co.
Great Lakes Carbon Corp. (Mining & Mineral Prod. Div.)
Grinnell Co., Inc.
Gurley, W. & L. E.

Hanchett Mfg. Co. ..... 105 A
Hauser-Stander Tank Co.
Heppenstall Company
Hercules Powder Co. ..... 53 A

Please mention *Tappi* when writing to Advertisers

SUSTAINING MEMBERS AND ADVERTISERS

Hermann Manufacturing Co.
Hoad & Associates, Inc., John G. ..... 203 A
Hodag Chemical Corp.
Holyoke Machine Co. ..... 165 A
Hooker Chemical Corp.
Hooper Corp., S. W.
Houghton & Co., E. F.
Huber Corp., J. M. (Paper Div.) ..... 4 A
Hubinger Co., The ..... 101 A
Huffman, Wolfe, Southern Co., The
Huntington Rubber Mills, Inc.
Huyck Felt Co. ..... 1 A

Improved Machinery, Inc. ..... 68 A
Industrial Nucleonics Corp.
Infilco, Inc.
Ingersoll-Rand Co.
Inglis Co., Ltd., John
Instron Engineering Corp.
Instrument Development Laboratories, Inc. ..... 22 A
Inta-Roto Machine Co., Inc. ..... 61 A
Interchemical Corp.
International Nickel Co., Inc. ..... 54 A
I-T-E Circuit Breaker Co. (Switchgear Div.)

Jagenberg-Werke A./G.
Jenssen Co., Inc., G. D. ..... 204 A
Johns-Manville Corp. (Celite)
Johns-Manville Corp. (Transite)
Johnson & Co., Inc., Alvin H. ..... 204 A
Johnson Corp., The ..... 49 A
Jones Corp., E. D. ..... 85 A

Kalle-Regulatorer, A./B.
Kamyr, Inc.
Keever Starch Co., The ..... 56 A
Kelco, The ..... 2 A
Kellogg Co., The M. W.
Keratine Co., Inc., The
Kidde Constructors, Inc., Walter ..... 204 A
Kinetic Dispersion Corp.
Knox Woolen Co.
Koppers Co., Inc. (Hopper-Swift Div.)
Koppers Co., Inc. (Plastic Div.)
Krauss-Maffei-Imperial

Laing Son & Co., Ltd., James
Langston Co., Samuel M. ..... 80 A
Lehman Co., Inc., J. M.
Levy Co., Inc., Frederic H.
Liberty Engineering Co.
Lindsay Wire Weaving Co.
Link-Belt Co.
Arthur D. Little, Inc. ..... 204 A
Litzler Co., Inc., C. A.
Lockport Felt Co.
Lockwood Greene Engineers, Inc. ..... 204 A
Lodding Engineering Corp.
Lummus Co., The ..... 204 A
Lunkenheimer Co., The

Main, Inc., Chas. T. ..... 204 A
Manchester Machine Co.
Marbon Chemical Co. (Borg Warner Corp.) ..... 63 A
Mason, Neilan Regulator Co.
Meincke & Sons, Inc., A. M.
Midland-Ross Corp.
Milton Roy Co.
Minerals & Chemicals Philipp, Inc. ..... 92 A
Minneapolis-Honeywell Regulator Co.
Mississippi Lime Co.
Mixing Equipment Co., Inc. ..... 46 A
Monsanto Chemical Co. (Plastics Div.)
Moore & White Co., The
Morden Machines Co. ..... 51 A
Morningstar Paisley, Inc.
Mount Hope Machinery Co.
Mount Vernon Mills, Inc. (Mt. Vernon Dryer Felt Co. Div.)
Murray Manufacturing Co., D. J. ..... 111 A

Nalco Chemical Co. ..... 27 A
Nash Engineering Co. ..... 78 A, 79 A
National Starch & Chem. Corp. ..... 45 A
Neville Chemical Co.
New England Lime Co.
New Jersey Zinc Co. ..... 95 A
Newport News Shipbuilding and Drydock Co.
Neyrpic
Nichols Engineering & Research Corp.
Noble and Wood Machine Co.
Nopco Chemical Co. ..... 50 A
Norton Company

Oakite Products, Inc.
O'Donoghue & Co., Roderick ..... 204 A
Ohio Blow Pipe Co. ..... 44 A
Ohmart Corp., The
Olin Mathieson Chemical Corp. (Chem. Div.) ..... 48 A
Orr Felt & Blanket Co., The
Owens Corning Fiberglas Corp.

Paper & Paper Products
Paper & Pulp Testing Lab. ..... 204 A
Parsons & Whittemore/Lyddon Organization
Patton Mfg. Co., Inc.
Peabody Engineering Corp.
Peacock Business Press, Inc.
Penick & Ford, Ltd., Inc. ..... 69 A
Penobscot Chemical Fibre Co.
Pennsylvania Industrial Chem. Corp.
Pennsalt Chemicals Corp.
Perkins & Sons, Inc., B. F.
Permutit Div., The (Pfaudler-Permutit, Inc.) ..... 10 A
Pfaulder Co., Div. (Pfaudler-Permutit, Inc.)
Pfeifer & Schultz ..... 204 A
Philadelphia Quartz Co.
Pittsburgh Plate Glass Co. (Chemical Div.) ..... 40 A, 41 A
Pope and Evans ..... 204 A
Portland Copper & Tank Works
Prior Chemical Corp.
Pyroxylin Products, Inc.

Ralston Purina Co.
Raybestos-Manhattan, Inc. ..... 8 A
Rayonier, Inc.
Reichhold Chemicals, Inc.
Reliance Electric & Engineering Co.
Research-Cottrell, Inc.
Rice Barton Corp. ..... 58 A
Riegel Paper Corp. ..... 17 A
Robbins Instrument Co., Inc. ..... 102 A
Rohm & Haas Co. (Resinous Products Div.)
Roots-Connersville Blower Div. (Dresser Industries)
Rosenblad Corp.
Ross Engineering Co., J. O.
Roy Co., Milton
Rust Engineering Co.

Sandoz Chemical Co.
Sandusky Foundry & Machine Co.
Sandy Hill Iron & Brass Works ..... 164 A

Please mention *Tappi* when writing to Advertisers

SUSTAINING MEMBERS AND ADVERTISERS

Scapa Dryers, Inc.
Scott Testers, Inc.
Shawinigan Resins Corp. ..... 89 A
Shuler & Benninghofen Co. ..... 99 A
Simmonds Saw & Steel Corp.
Simmons, Worden, White Co.
Simplex Wire & Cable Co.
Sinclair Co.
Sinclair & Valentine Co.
Sirrine Co., J. E. ..... 204 A
SKF Industries, Inc.
Smidth & Co., F. L.
Smith Corp., A. O.
Socony-Mobil Oil Co.
Southern Clays, Inc.
Southworth Machine Co.
Sprout, Waldron & Co., Inc. ..... 73 A
Square D Co. (E. C. & M. Div.) ..... 3 A
S & S Corrugated Machinery Co.
Staley Mfg. Co., A. E.
Stebbins Engineering & Mfg. Co.
Stein, Hall & Co., Inc.
Stevens, Inc., Charles R.
Stickle Steam Specialties Co. ..... 105 A
St. Lawrence Starch Co.
Stone & Webster Engineering Corp.
Stowe-Woodward, Inc. ..... 59 A
Sun Chemical Corp.
Sunday & Associates, George M.
Swenson Evaporator Co.

Taylor Instruments Cos. ..... 30 A, 31 A
Tennessee Corp. ..... 102 A
Testing Machines, Inc.
Texas Gulf Sulfur Co. ..... 21 A
Thiele Kaolin Co.
Thwing-Albert Instruments Co. ..... 127 A
Tidewater Construction Corp.
Tidland Machine Co.
Titanium Pigment Corp. ..... 88 A
Tracerlab, Inc.
Tragacanth Importing Corp. (TIC)
Traylor Eng. Mfg. Div. (Fuller Co.)
Trimbey Machines, Inc.
Tyler Co., W. S.

Union Screen Plate Co. of Canada
Union Starch & Refining Co.
United Eng. & F'dry Co.
United States Movidyn Corp.
U. S. Industrial Chemicals Co. (Div. Natl. Distillers & Chem. Corp.)
U. S. Rubber Co. (Naugatuck Chem. Div.)

Valley Iron Works Corp. ..... 24 A, 25 A
Valmet OY
Vanderbilt Co., Inc., R. T. ..... 13 A
Vermont Kaolin Corp.
Vineland Chemical Co.
Virginia Chemicals & Smelting Co. (Industrial Div.)

Waldron-Hartig Div. (Midland-Ross Corp.) ..... 20 A
Wallace & Tiernan, Incorporated ..... 160 A
Wallerstein Co. (Baxter Lab., Inc.) ..... 97 A
Warren Pumps, Inc.
Waterbury & Sons Co., H.
West End Chemical Co. (Div. Stauffer Chem. Co.) ..... 70 A
Western Precipitation Div. (Joy Mfg. Co.)
Westinghouse Electric Co.
Weyerhaeuser Co.
Whittaker, Clark & Daniels, Inc.
Wica Chemicals, Inc.
Wilco Machine Works, Inc.
Wisconsin Wire Works
Wyandotte Chemical Corp. (Michigan Alkali Div.) ..... 113 A, 115 A, 117 A

Youngstown Miller Corp.

Zeiss, Inc., Carl

Please mention *Tappi* when writing to Advertisers

GUIDE TO PROFESSIONAL SERVICES

CUMMINS & BARNARD, INC.
Financial Comparisons and Analyses
Steam, Electric, and Process Systems
Plans, Specifications, and Construction Management
2058 South State Street, Ann Arbor Michigan
Pensacola, Florida Whittier, California
Engineers Serving the Industry since 1932

GILBERT ASSOCIATES, INC.
Engineers and Consultants
• Generation, Distribution and Application of Steam and Electric Power • Waste Treatment • Water and Sanitary Facilities • Studies and Reports • Plans and Specifications • Supervision of Construction
New York, N. Y. **Reading, Pa.** Washington, D. C.

THE H. K. FERGUSON COMPANY
A Subsidiary of Morrison-Knudson Company, Inc.
INDUSTRIAL ENGINEERS & BUILDERS
PULP & PAPER DIVISION
Study—Design—Construction—Start-up
Main Office: Cleveland, Ohio
Other Offices: New York • San Francisco • London • Paris • Sao Paulo

Complete professional engineering services
for the pulp and paper industry
JOHN G. HOAD & ASSOCIATES, INC.
Consulting Engineers
YPSILANTI, MICHIGAN

GUIDE TO PROFESSIONAL SERVICES

G. D. JENSSEN CO., INC.

49½ Maple St., P.O. Box 366, Massena, N. Y.

SULPHITE MILL ACID PLANTS—SEMICHEMICAL LIQUOR PLANTS
Sulfur Burning Plants • Jenssen Two Tower Acid Systems • Gas Coolers—Surface and Spray Type • Jenssen Pressure Acid Systems • Jenssen Auxiliary Process Towers • Recovery Plants—Cooking Acid
SOLUBLE BASE ACID PLANTS •
JENSSEN SO_2 ABSORPTION SYSTEMS
Sulfurous Acid Preparation for Bleach Plant Application
West Coast Representative—JAMES BRINKLEY COMPANY
417—9th Avenue South—Seattle, Washington

CHAS. T. MAIN, INC.

ENGINEERS

Process Studies, Design, Specifications and Construction Supervision

PULP AND PAPER MILLS

Steam Hydraulic and Electrical Engineering
Reports, Consultation and Valuations

80 Federal Street, Boston 10, Mass.
129 West Trade Street, Charlotte, N. C.

ALVIN H. JOHNSON & CO., INC.

415 LEXINGTON AVENUE NEW YORK 17, N. Y.

CONSULTING AND DESIGNING ENGINEERS

Serving the Pulp & Paper Industries Since 1929

Telephone MUrray Hill 7-8764

RODERICK O'DONOGHUE & COMPANY

CONSULTING ENGINEERS TO THE PULP AND PAPER INDUSTRY

IMPROVED PROCESSES—DESIGNS—REPORTS

420 Lexington Ave. New York 17, N. Y.

WALTER KIDDE CONSTRUCTORS, INC.
WALTER KIDDE ENGINEERS SOUTHWEST, INC.

World Wide Services to the Pulp and Paper Industry

STUDIES, REPORTS, PLANNING, SITE SELECTION, DESIGN, ENGINEERING, PROCUREMENT, EXPEDITING, INSPECTION, CONSTRUCTION

PACKAGE CONTRACTS

NEW YORK • CHICAGO • HOUSTON • BATON ROUGE

Infrared Spectroscopy
UV-VIS-NIR Spectroscopy
Gas Chromatography

Certified Pulp Testers

PAPER AND PULP TESTING LABORATORIES

118 East 28 Street
New York 16, N. Y.

ARTHUR D. LITTLE, INC.

Science • Management • Engineering

Consultants Since 1886

Main Offices and Laboratories: Acorn Park, Cambridge, Mass.

Also: New York, Washington, Chicago, San Francisco, Santa Monica, San Juan, Toronto, London, Zurich, Edinburgh, Mexico City

PFEIFER & SHULTZ...Engineers

Steam Power Plant Specialists

- Mills and Industrial Buildings
- Reports
- Plans and Specifications
- Supervision of Construction

Wesley Temple Bldg. Minneapolis 3, Minn.

LOCKWOOD GREENE, ENGINEERS, INC.

Est. 1832

Plant Location • Site Studies • Paper • Pulp Mills • Mill Expansion • Water • Waste • Steam-Electric Power and Utilization • Reports • Appraisals

New York 17, N. Y., 41 East 42nd Street
Spartanburg, S. C., Montgomery Bldg.
Boston 16, Mass., 316 Stuart Street

POPE and EVANS

Consulting Engineers

Surveys Reports Design
relating to the
Generation, Distribution and Utilization
of
Steam and Electric Power

Main Office: 21 East 40th Street, New York 16, N. Y.

THE LUMMUS COMPANY

for over half a century
Engineers and Constructors
for Industry
PULP AND PAPER MILL DIVISION
design, construction, reports, consultation

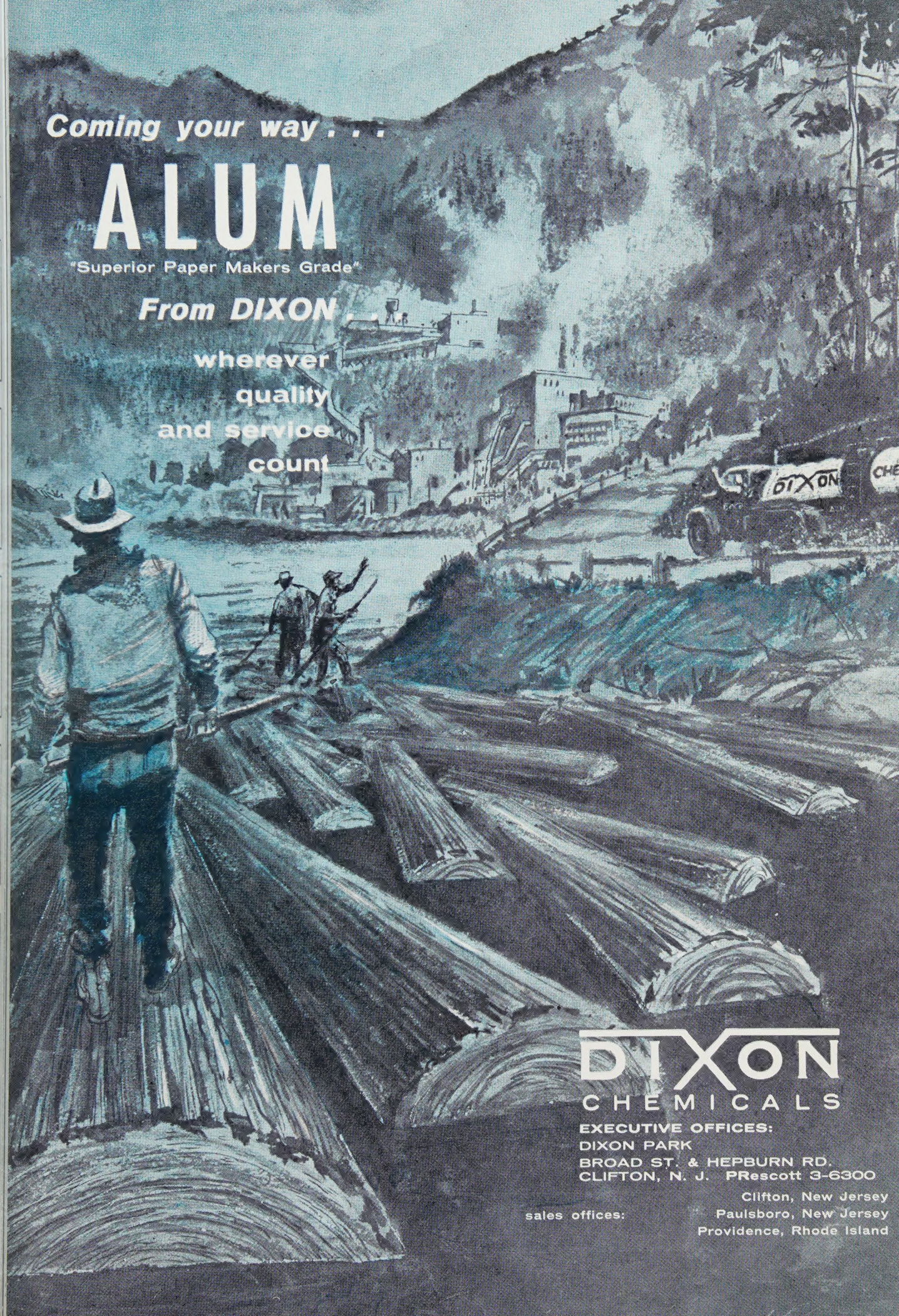
385 Madison Ave., New York 17, N. Y.
Newark, Houston, Washington, D. C., Montreal, London, Paris, The Hague, Madrid

J. E. SIRRINE CO. Engineers

Greenville, S. C.

Est. 1902

Paper • Pulp Mills • Waste Disposal • Textile Mills • Appraisals • Water Plans • Steam Utilization • Steam Power Plant • Hydro-Electric • Reports


Coming your way . . .
ALUM
"Superior Paper Makers Grade"
From DIXON . . .
wherever
quality
and service
count
DIXON
CHEMICALS
EXECUTIVE OFFICES:
DIXON PARK
BROAD ST. & HEPBURN RD.
CLIFTON, N. J. PRescott 3-6300
sales offices:
Clifton, New Jersey
Paulsboro, New Jersey
Providence, Rhode Island

BUSAN

TRADEMARKS REGISTERED
U. S. Pat. Off. and in Other Countries

Serving the Paper Industry
Throughout the World

BUCKMAN
LABORATORIES, INC.
MEMPHIS 8, TENNESSEE, U.S.A.
CABLE ADDRESS BULAB